ELECTRICAL REVIEW

[ILLUSTRATED]

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(Formerly Review of Telegraph and Telephone.)

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The Colburn System of Electric Lighting and Plating.

On every hand we find exemplified the old saying, "Still waters run deep;" in no case, however, more forcibly than in a study of the history and success of the system before us. This system has many points of scientific interest, as well as many exceptionally excellent features of a commercial nature.

I. W. Colburn & Co., of Fitchburg, Mass., manufacture complete systems of arc and incandescent lighting, each of which has obtained enviable favor, due to economy in maintenance and completeness of operation; suffice it to say that its firmest friends are among its largest consumers. The simplicity of mechanism and compactness of parts are the most striking optical features of both systems, and at once point to freedom from easy derangement and economy in point of wear and tear. Again, the general absence of the ultra-violet or bluish rays in the arc light, due to its low tension current and short length of arc, are notable equally with the extreme steadiness and great diffusiveness of illumination.

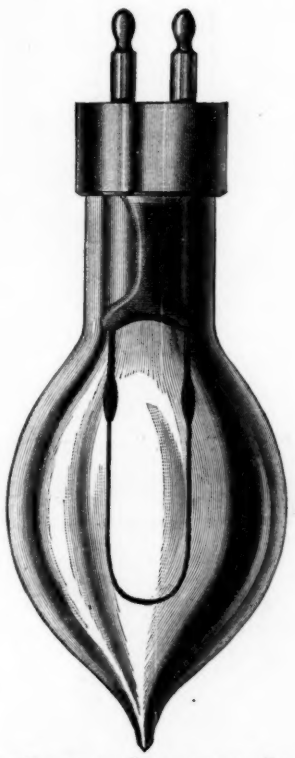
The dynamos generate currents of particularly low tension, thus doing away with all the possible danger or inconvenience with which a system of more intense current is fraught. These machines consist simply of a strong iron frame, with the electro-magnets set radially around the armature.

The armature is of an original pattern, the core of which is made up of soft wrought iron pieces. These pieces are insulated from each other by thin layers of asbestos paper, thus preventing the generation of the wasteful Foucault current. The use of soft wrought iron instead of cast iron in the armature is for the purpose of effecting a diminution of the amount of useless work performed by the magnetic field in the reversal of the polarity of the core, which occurs four times during each revolution, the molecules of wrought iron being less rigid in their position than cast iron are, hence more easily polarized. In addition, ample ventilation is secured, together with smoothness of working.

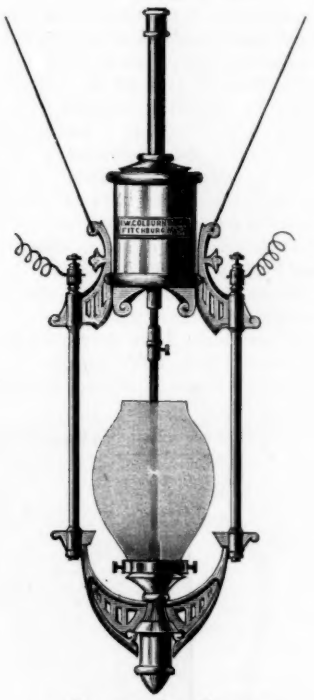
There is but little sparking at the commutator, and very little external magnetism noticed, thus showing that the magnetic field is concentrated about the armature, and that there is slight loss of energy in the machine itself. This, combined with a claim of minimum heating of parts, tends to place its efficiency at a high figure.

The arc lamp is of a very graceful pattern, and constructed with a view of casting as few shadows as possible. It contains no clockwork nor intricate mechanism, liable to get out of order, and is, in fact, in entire keeping with the rest of the system in point of simplicity. The clutch system of feeding and differential method of regulation are employed, and each lamp is supplied with an automatic switch and cut-out, so that in event of fault, or the carbons being consumed so as to endanger the carbon holders, the lamp will be automatically switched out of circuit without in the least affecting the other lamps.

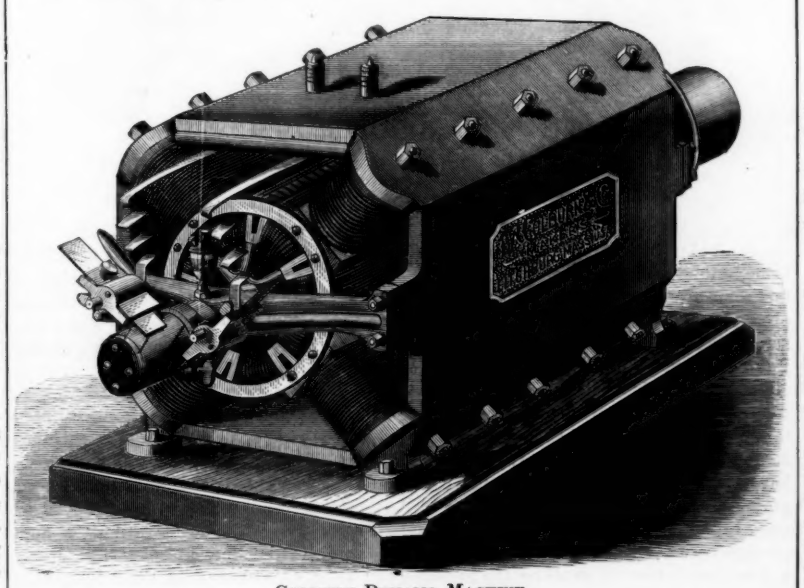
In the incandescent system of the Colburn Company the Bernstein lamp is used, the more important characteristics of which are its low resistance and large light-giving surfaces. This increase of light-giving surface, whilst it decreases the intense brilliancy of light of the smaller surface, greatly increases its diffusiveness and gives rest to the eye. General mention only will be made of this lamp on the present occasion; but our readers may look for its more detailed and technical treatment in a subsequent issue of the REVIEW. The Bernstein lamp consists, essentially, of a glass globe containing at its lower end a piece of enamel, into which the conducting wires are sealed. These wires terminate in carbon bulbs, to which the light-giving carbon is attached. This consists of a hollow cylinder of carbon with very thin sides, thus attaining low resistance with large surface. Four standard sizes of these lamps are made, viz.: 30, 60, 120 and 175 candle-power respectively. A new style of cut-out for these lamps has been lately devised, and is used with size "E." Two of these lamps may be used in place of one arc light on the same circuit with fifty or more arc lights, and this arrangement is adapted so as to be used with any system of arc lighting. It consists of a group of two lamps, and is so arranged that in event of breaking one of them the current is automatically cut off from it, and the other lamp is thrown into circuit; in case this second lamp gives out in any manner, it, in turn, is short circuited. This lamp is used not only in circuit with arc lights, but upon circuit by itself, the electrical arrangement being such that the cost of conductors is about the same as for arc lighting, which is a great advantage over the ordinary system of incandescent lighting in multiple arc. Whilst apparent economy, measured in volt-amperes, is greater as the resistance of the lamp is increased, at the same time the cost of production of electric energy is greater per volt-ampere as the volts increase, while the cost of transmission increases with the amperes. In this lamp we find it is claimed 175 candle-power is developed from 250 volt-amperes, or about one-third of a horse-power in the lamp, and this exceptional performance is obtained neither from an excessively intense current or high E.M.F., as may be seen. The gain, then, is a proportionately low cost of production combined with a moderate cost of transmission.



THE BERNSTEIN INCANDESCENT LAMP.



COLBURN ARC LAMP.



COLBURN DYNAMO MACHINE.

The electro-platers of this company are well known, and possess the characteristics that go to make up a good machine, first and foremost of which is the absence of heating in the armature. This is effected by leaving ample air spaces between the pieces composing the core, thus obtaining thorough ventilation and a complete separation of parts. In general, it may be said that the Colburn system of lighting and plating is well worthy special interest and commendation, not only for its perfection, but for the untiring zeal and discrimination of adoption which has effected it.

Electric Annunciator, Guest Call and Fire Alarm.

The Security Electric Signal Company of New York are the manufacturers of a new style of hotel annunciator.

This apparatus can be used to great advantage in hotels, apartment houses, schools, hospitals, factories, ocean and river steamers, etc., to transmit signals to and from the various rooms.

In connection with an ordinary annunciator, such as used in hotels, electric bells and spring circuit-closers are placed in all of the rooms, and a cabinet, containing as many spring circuit-closers as there are rooms, is placed near the annunciator in the office or other central point.

In hotels and steamers guests or passengers can be called at any specified time without the occupants of adjoining rooms being annoyed by a knocking upon the door. The clerk or person in the office merely presses upon the spring bearing the number of the room to be communicated with, which causes the bell in that room to ring continuously until it is heard by the occupant. A peculiar device in connection with the system enables the person in the office to know that the bell is ringing, and to be notified when the guest has been aroused. This not only does away with the very objectionable knocking, which disturbs so many others beside the person for whom it is intended, but also effects a saving in the number of employees who are used for such purposes,

as it is unnecessary for any one to be sent to the rooms to awaken the occupants.

When a guest desires to summon a servant from the office, a touch upon the spring in the room causes the room number to be displayed in the annunciator in the same manner as with the ordinary push button system. When a summons of this kind has been received, the clerk in the office can immediately, by touching a spring bearing a corresponding number, cause the bell in the room to tap. This informs the guest that the call has been heard and will be given attention—thus avoiding unnecessary and confusing repetitions of the call.

The most important feature of the system, however, is its great usefulness in case of fire or other danger of which it would be necessary to inform the occupants of all the apartments quickly. By simply moving a single crank in the cabinet which is placed in the office, all of the bells are made to ring simultaneously, and they will continue to ring without any further attention from the person in the office. This notifies the guests instantly, and gives them a much better opportunity to escape than could be done by any other method. At the same time an alarm can be sent in the same manner to the nearest fire engine and police stations if suitable wire connection is maintained therewith, thus effecting a great saving of time in getting assistance from those departments.

Where electric annunciators are already in use they, and the wires in connection with them, can be availed of for attaching this system.

We were also shown by General-Manager Shivler at their warerooms under Fifth Avenue Hotel an Automatic Fire Indicator, which is used in connection with an annunciator for showing the location of a fire as soon as it has started to burn in any part of a building. It differs from the ordinary thermostat in being operated upon a closed circuit, and is therefore less liable to fail when needed.

Electrical Communication Between Vessels at Sea.*

A few years ago I made a communication on the use of the telephone in tracing equipotential lines and surfaces. I will briefly give the chief points of the experiment which was based on experiments made by Prof. Adams, of King's College, London. Prof. Adams used a galvanometer instead of a telephone.

In a vessel of water I placed a sheet of paper. At two points on that paper were fastened two ordinary sewing needles which were also connected with an interrupter that interrupted the circuit about 100 times a second. Then I had two needles connected with a telephone; one needle I fastened on the paper in the water, and the moment I placed the other needle in the water I heard a musical sound from the telephone. By moving this needle around in the water, I would strike a place where there would be no sound heard. This would be where the electric tension was the same as in the needle; and by experimenting in the water you could trace out with perfect ease an equipotential line around one of the poles in the water.

It struck me afterwards that this method which is true on the small, is also true on the large scale, and that it might afford a solution of a method of communicating electrical signals between vessels at sea.

I made some preliminary experiments in England and succeeded in sending signals across the river Thames in this way. On one side were two metal plates placed at a distance from each other, and on the other two terminals, connected with the telephone. A current was established in the telephone each time a current was established through the galvanic circuit on the opposite side, and if that current was rapidly interrupted you would get a musical tone.

A few years ago I found that our distinguished president, Prof. Trowbridge, had very similar ideas in connection with the possibility of communicating between vessels in a fog. Using a dynamo machine for charging the water, a distant vessel might receive signals when getting in dangerous proximity to the other.

Urged by Prof. Trowbridge I made some experiments which are of very great value and suggestiveness. The first was made on the Potomac River.

I had two boats. In one boat we had a Leclanché battery of six elements and an interrupter for interrupting the current very rapidly. Over the bow of the boat we made water connection by a metallic plate, and behind the boat we trailed an insulated wire, with a float at the end carrying a metallic plate, so as to bring these two terminals about 100 feet apart. I then took another boat and sailed off In this boat we had the same arrangement, but with a telephone in the circuit. In the first boat, which was moored, I kept a man making signals; and when my boat was near his I would hear those signals very well—a musical tone, something of this kind, tum, tum, tum. I then rowed my boat down the river, and at a distance of a mile and a quarter, which was the furthest distance I tried, I could still distinguish those signals.

It is therefore perfectly practicable for steam vessels with dynamo-machines — and most large steam vessels use the electric light, which requires a large dynamo-machine—to know of each other's presence in a fog when they come, say, within a couple of miles of one another, or, perhaps, at a still greater distance. I tried the experiment a short time ago in salt water of about twenty fathoms in depth. I used then two sailing boats, and did not get so great a distance as on the Potomac. The distance, which we estimated by the eye, seemed to be about half a mile; but on the Potomac we took the distance accurately on the shore.

Prof. Trowbridge: I am very glad you have all heard Prof. Bell's exposition of a subject of this nature in which I think he excels all of us in America. He has referred to me in this connection, but I can only say that some years ago I published an account of a plausible method of sending signals across the Atlantic Ocean without any cable. I do not mean you to infer that it is at all practicable, but it is possible. If you will allow me for a moment: Suppose this represents the two continents (making an outline of the continents). If you should have a dynamo machine in Philadelphia and ground one terminal in Patagonia and the other in Labrador, then a telephonic circuit through here (indicating) would enable you to hear signals that are made on the first circuit. It is perfectly possible. In fact I have tried the same experiment which Prof. Bell refers to in Cambridge, at a lake called Fresh Pond. I then heard signals sent from Boston to Waltham, a distance of ten or twelve miles, by simply having the terminals of the telephone—that wonderful instrument invented by Prof. Bell—in Fresh Pond, where they must have been a long distance away from the earth of battery.

In regard to the fog signals at sea my effort has been in a somewhat different direction. My effort has been to ascertain with galvanometers the direction of vessels which are approaching. The arrangement is like Prof. Bell's. Each vessel carries a dynamo-machine, grounds one terminal of the circuit at the bow, and trails a wire, uninsulated, at the end only, over the stern. Each vessel is provided with a cross-arm and a galvanometer in the circuit, of which the terminals enter the water at the ends of the cross-arm. When one vessel comes within the field of the other the galvanometer will show how the equipotential lines are disturbed, and if you had a careful map of those equipotential lines you could ascertain where the other vessel was. The method could also be applied to saturating water in the neighborhood of a rock, and you could take electrical soundings, so to speak, and ascertain your place from electrical maps carefully made out.

Mr. W. H. Preece: If you will allow me the use of the board I think I can give the section details of a real and practical experiment, which combines both the ideas of Prof. Bell and Prof. Trowbridge. In the South of England we have a charming island called the Isle of Wight. This is separated from the main land of Hampshire by a channel of a mile and a quarter at one end and about six miles at the other. Portsmouth comes here (indicating) and is distant across about six miles. Then comes the narrow channel, called Hurst Castle, and Southampton is here (indicating). Newport, in the centre of the Isle of Wight, is there (indicating).

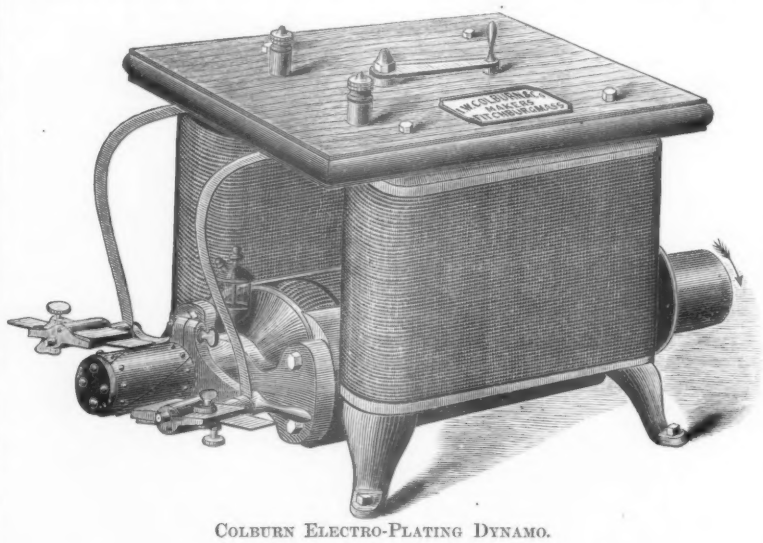
The Isle of Wight is a very busy place. There are several important towns; the Queen's marine residence is there, and the cable across at Hurst Castle is of consequence. For some cause the cable broke down, and it became of great importance to know whether we could communicate across, so I thought it a timely opportunity to test the ideas that had been promulgated by Prof. Trowbridge. I put a large plate of copper about six feet square in the sea at the end of the pier. A wire passed from there to Newport and from Newport to Hurst Castle, and in the sea there I placed another copper plate. Opposite at Hurst Castle was a similar plate, and the wire passed from there overground to Southampton, from Southampton down to Portsmouth, and then into the sea again at Southsea Pier. We have here a complete circuit if we take into consideration the water, the circuit starting from Southampton to Portsmouth through the sea, six miles to Newport, to Hurst Castle, thence across to Hurst Castle, a mile and a quarter, and thence to Southampton again.

We connected the telephones in the circuit, but we could not converse by them. But when we placed at Southampton and Newport what are called "buzzers"—they are little instruments that make and break the current with great rapidity, and make a buzzing sound, and for every vibration send a current into the circuit—with these buzzers and about twenty-five cells of Leclanché it was quite possible to communicate between Newport and Southampton, although the circuit was broken by six miles of sea at one end and one mile and a quarter at the other. If it had not been that the cable was repaired the very next day communication would have been continued between the mainland and the Isle of Wight in this manner. And when the cable breaks down again telegraphic communication will be conducted across the Solent, a distance of six miles and a mile and a quarter, by the same means I have described to you to-day.

Prof. Valentiner (of Germany): Several years ago I made a lecture room experiment, which may be of benefit to professors. Take an elongated trough, and place on one side a battery with a key; then here a plate, another plate on the other side, with a galvanometer in the circuit to detect the current, here a plate, with another on the opposite side, finally returning to the battery with the key. If the trough be filled with water any movement of the key here will cause a deviation of the needle of the galvanometer. It does not need a very strong battery to do that. I tried that experiment on one of the canals in Holland on a large scale, but I found that the results were very doubtful. I see now that the current was too weak.

* An abstract of a paper read by Mr. A. Graham Bell, with discussion thereon, American Association for the Advancement of Science.

125 Candle-Power Bernstein Lamp.



Colburn Electro-Plating Dynamo.

To Test the Electric Motor.

A number of electricians and capitalists met in the office of Cyrus W. Field on Thursday, and completed the subscription to the stock of the new American Electric Railway Company. A sufficient amount of money has been raised to lay extra rails on the Second Avenue elevated railroad structure, and to make a thorough test of the electric motor. The certificate of incorporation of the company has been filed in the County Clerk's office. The corporators and trustees for the current year are Cyrus W. Field, Edward H. Johnson, Frederick F. Thompson, Stephen D. Field, Robert E Deyo, Edward N. Dickerson, Jr., Charles Batchelor, Francis R. Upton, and Daniel A. Lindley. The capital stock is $1,000,000, divided into shares of $100, and the company's purpose is stated to be to build, own, sell, or let locomotive engines, cars, rolling stock generally, and railway machinery.

A Novel Engine.

We present to our readers herewith a description of an engine now offered for sale, in which the manufacturers claim there are no dead centers, and in which the force of the steam is always exerted at a right angle to the crank. These claims are quite broad in application.

The simplicity of construction is at once a noticeable feature, and though four cylinders, with their pistons are used, the whole number of other moving parts are but two, making six in all.

To open and close the four ports, and to alternately expand and compress the steam in these ports require but one valve, which is a flat disk hung upon a pin which is eccentric to the shaft and represented by the letter *J*, in the engraving:

On this pin the valve is free to revolve, and in so doing it is given a gyrating motion, owing to the combined motion of the eccentric pin and its revolving at the same time upon that pin, this ensures an equal amount of wear on all parts of the valve, and also a perfectly steam-tight joint. The block ring represents the exhaust passage connecting with the outlet *E*, the four openings *F* being the ports for inlet of steam. By placing the valve upon the pin *J* we cover the ports, as shown in Fig. 3, one only being open for steam to enter, the port opening on the inside of the valve is exhausting its steam through the exhaust ring with which it is in communication, the bridges in no manner interfering with its passage as they do not extend the full depth of the valve. In any position in which the crank may be stopped it will always be found that the valve has left a port open for the admission of steam, so that upon steam entering the steam chest it enters the open port and immediately puts the engine in motion.

In Fig. 4 we have a cross-sectional view which more clearly shows the internal mechanism. Here we see the eccentric pin on which is hung the valve, which valve is enclosed on either side, so that steam circulates upon its circumference, but not on its sides, thereby perfectly balancing it. The upper port is admitting steam to the piston, which receives it only on one end, while the other cylinder is open to the exhaust. We now come to that most important part, the application of the power of the steam to the crank.

In Fig. 5 we have a view of the four cylinders with their pistons. In whatever position the crank may be, it must be seen that the force is exerted at 90°. If we suppose the top piston to be exerting its force at 70° the left hand piston must be exerting its force at 20°, and as the crank moves to the right and downward the uppermost piston will exert its force at 71°, while the other exerts its force at 19°, and so on throughout the entire revolution.

In economy of steam, they should be very satisfactory, as they claim that the steam cannot escape until it has done its full work, The compression fully equals the area of the parts, and friction must be but a very small proportion of the whole as there is not a stuffing box in any portion of the engine. The point of lubrication seems to have been well studied and brought to perfection. The crank-pin is oiled through the crank from the outside bearing, while the valve shaft is oiled direct by means of the dotted lines in Fig. 2. Every detail of construction gives evidence of the careful attention and thoughtful study.

They have been run as high as 1,200 revolutions per minute, and the makers claim they can be connected direct to the shaft of the dynamo and avoid loss from slipping belts as well as the unequal bearing in the shaft of both engine and dynamo.

These engines are manufactured by the Cowdrey Four Cylinder Engine Company, Chicago.

The decision of Judge Lawrence, affirming the right of the Quincy Mining Company to withdraw from the Lake Superior Copper "pool," which is controlled by the Calumet & Hecla Company, is a matter of interest to all electrical people, inasmuch as it tends to break up a monopoly which has long kept copper at an unreasonable figure. The *New York Commercial Bulletin* says: "The former policy of the Calumet & Hecla Company, of forcing home consumers to pay three to five cents a pound beyond what the company sold at to European buyers, was a serious grievance, but since that concern attempted to subject the interests of other mining companies in the 'pool,' and virtually the entire business of the country in manufactures of copper also, to the whims of London speculators, as it did in binding the 'pooled' companies to accept prices on sales to American consumers based upon the value of a foreign article in a foreign market, there has been no little indignation in the trade. Now that a precedent has been established, it is a question whether other companies will not break from the Calumet & Hecla monopoly, and that they will choose, instead of being at the mercy of London speculators, to stand or fall on a legitimate trade basis." It is to be hoped that they will. The fact is that copper ought, on the basis of supply and demand, which is always a safe basis to go upon, to be very much cheaper than it is, and it is very much for the interest of all electrical enterprises that it should be. Lake copper is a thing apart; no other copper can compete with it for electrical and some other purposes, and this fact is all the "protection" it needs. Perhaps a "legitimate trade basis" might cut into Calumet & Hecla's princely dividends, but it must be remembered that its mine contains quite as much "water" as copper.

A dining car on the "New England, limited" of the New York & New England Railroad is lighted by a dozen incandescent lights, and the experiment gives promise of being very successful. The lights are supplied by batteries which are placed in a little room adjoining the stateroom. There are four batteries of six cells each. The battery consists of a wooden trough in which are fitted half a dozen ebonite cells. It is not claimed that the light is as cheap as that furnished by oil lamps, but it is better and much safer, and is said to be as cheap as gas at $2 per 1,000 feet.

Statistics of Electrical Patents Issued from the U. S. Patent Office in 1884.

By T. D. Lockwood.

The following statistics relative to the issue of electrical patents during the year 1884 have at least one merit. They are early, and, I think, correct. As every one knows, who has tried to classify electrical patents, the work is not easy. A patent for a cable, for example, may include a device for preventing induction; in such cases I have regarded the patent as being for the invention claimed.

The total number of patents issued for electrical inventions during 1884 is 1,166. Total number of Patents issued in 1884 is 18,799.

SUBJECTS OF INVENTION.

Telegraphs.	
Autographic Telegraphs	3
Automatic	7
Fire Alarm and District Telegraphs	30
Telegraph Instruments, Keys, Relays, Repeaters, etc	17
Multiple Telegraphs, Duplex, Quadruplex, etc	19
Printing Telegraphs	32
Telegraphy—New Systems	13
Alarms.	
Annunciators—Indicators and Alarms	42
Burglar Alarms and Watch Clocks	10
Railroad Signals	46
Electric Lighting.	
Arc Lamps	82
Incandesing Lamps	40
Electric Lamp Fixtures and Fittings	25
Electric Lighting Apparatus, Switches, Cut outs, etc	30
Sources of Electricity, Primary or Otherwise.	
Primary Voltaic Batteries	31
Dynamos, and parts thereof	75
Regulators for Dynamo Electric Machines	22
Secondary Batteries	36
Conductors.	
Cables, Compound Conductors and manufacture of the same	41
Insulated Wires, etc	17
Insulating Materials.	
Line Wire, Compound Wires, etc	13
Underground Systems	51
Construction.	
Couplings, Binding Screws, Joints	11
Inside Construction	1
Insulators for Pole Lines	18
Supports and Poles	14
Special Systems of Utilization.	
Clocks, Time Regulators and Distributors	30
Electric Distribution and meters	23
Remedies against induction, etc	11
Electric Gas Lighting	12
Lightning Arresters, and Protectors against abnormal currents	19
Transmission of Power, Motors and Railroads	45
Electro-magnets	6
Galvanometers and Measurement	5
Switchboards, and apparatus therefor	13
Telephones, and Telephonic Appliances.	
Transmitters	51
Receivers or Reproducers	26
Telephone Apparatus including automatic switches, etc., but excluding signals	40
Telephone Exchange Systems, and circuit arrangements	18
Individual signals	6
Telephonic Repeaters or Relays	2
Telephone Signaling Appliances	22
Mechanical Telephones	14
Miscellaneous. Applications	80

It is thus seen that telephonic invention still heads the list with 179 patents, electric lighting closely following with 177.

Considering the inventors from an alphabetically-arranged list, it is found that the number of patents assignable to each letter of the alphabet is as follows:

Inventors having the initial A = 21; B = 107; C = 57; D = 49; E = 39; F = 47; G = 60; H = 93; I = 1; J = 24; K = 32; L = 45; M = 58; N = 10; O = 10; P = 63; Q = 0; R = 44; S = 150; T = 60; U = 1; V = 60; W = 133; X = 0; Y = 1; Z = 1—total, 1,166.

The banner letter is thus found still to be S, presumably owing to the legendary impatience of our common ancestor Adam, who, it is said, after naming the greater part of his descendants became very tired, and gave utterance to the immortal dictum, "Let all the rest be named Smith."

The letter W takes the second place with 133, owing to the inventive efforts of Messrs. Weston and Waring; while B is third with 107. The letters Q X alone are unrepresented.

I, U, Y and Z, have 1 each.

In 1884 there were 53 weekly issues of patents. The average weekly issue is exactly 22 electrical patents.—*Electrician and Electrical Engineer.*

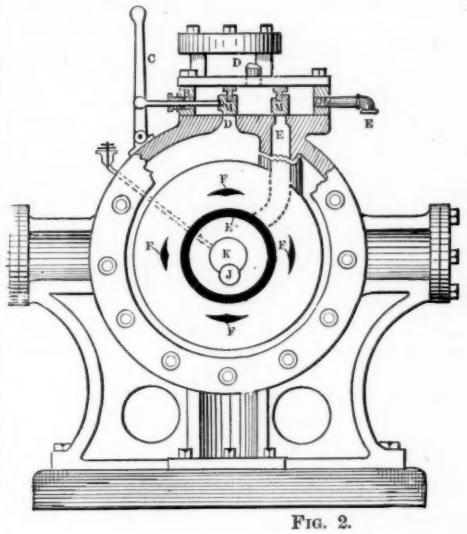


Fig. 2.

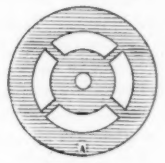


Fig. 1.

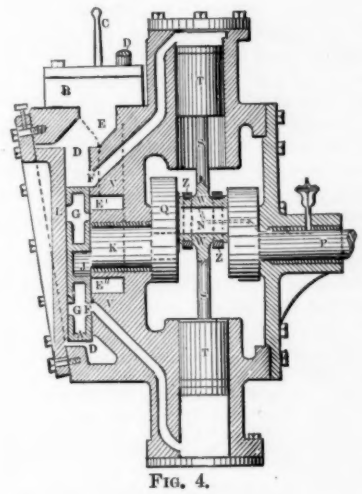


Fig. 4.

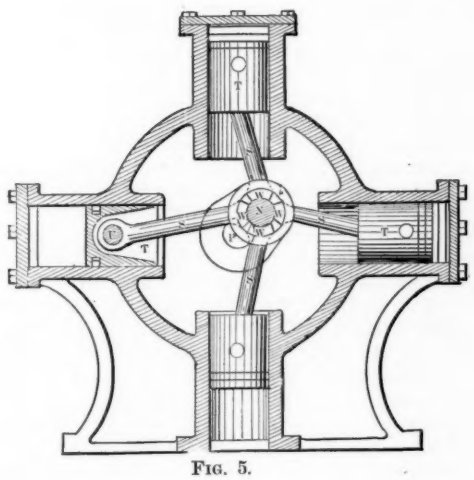


Fig. 5.

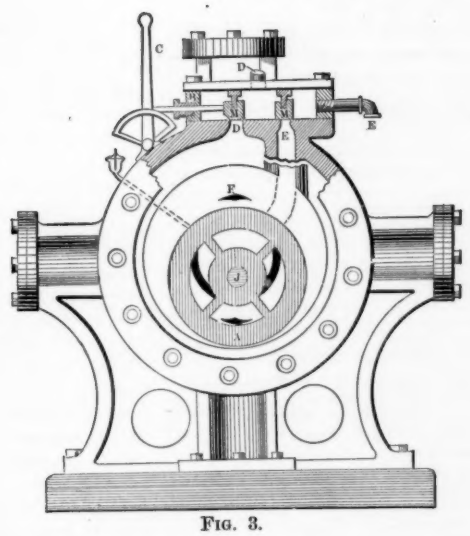


Fig. 3.

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We extend to manufacturers of electrical apparatus an invitation to send to this office any and all facts concerning their business which will be of interest to the public. We make no charge for publishing news.

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NEW YORK, FEBRUARY 14, 1885.

CONTENTS.

	PAGE
Colburn System of Electric Lighting and Plating	1
Electric Annunciator, Guest Call and Fire Alarm	1
Electrical Communication Between Vessels at Sea	2
To test the Electric Motor	2
Cowdrey Four Cylinder Engine	3
Statistics of Electrical Patents Issued from the U. S. Patent Office in 1884	3
Editorial Notes	4
The Future of the Electric Light	4
The Protection of Submarine Cables	5
Secondary Batteries	5
Telephonic News	6
The Telephone in Business in Mexico	6
Improvement in Telegraphing	6
Telephony in France and in England	6
The Telephone in the Metropolis	7
Telegraphic News	7
Electrical and Scientific	8
On the Fritt's Seleneum Cells and Batteries	8
Large and Small Dynamos	9
Electric Light News	9
Electrical Patents	10

The closing of small exchanges in the West on account of insufficient income to support them, brings the question of switchboard or automatic service in the fore again. Many inventors have coped with this problem, and so far no one has evolved a solution. We have faith that some can so devise a system whereby a subscriber can call one up to a hundred, and have communication without the operator as now assisting in the performance. This accomplished will bring many communities now without the telephone into closer relations to their more fortunate neighbors—of course, to their mutual benefit. The telephone companies are ready to adopt that system which will give them opportunity to give the smallest towns service, if it will do so at a very much less expense than now. Here is a field for the prolific inventor of telephonic devices, and assurance is doubly sure that the pecuniary result will be more than satisfactory.

Who is the man to come forward to fill this want?

During the present decade one hundred and thirty-eight telegraph and telephone companies have been organized in the State of New York, their aggregate capital exceeding $225,000,000. Of course very many of these never had any existence save on paper.

While the telephone people are reaching out for long distance business, the telegraph companies, especially in the large cities, are cultivating the short distance branch of their work. It is said that New York has not less than two hundred and fifty telegraph offices, and that a great proportion of the business that comes to the most of these is made up of messages of a purely local character. For the mere sending and delivery of a message the telegraph is cheaper, quicker, and more certain than a messenger boy, while the use of the telephone is practically restricted to subscribers; for, although there are pay stations, it is only with subscribers that one can be connected. The local use of the telegraph has of late increased very rapidly; new offices are constantly being established, and unless the business is interfered with by underground foolishness, their number is destined to increase rapidly.

The Legislature of Pennsylvania has before it a law whose purpose and object it is to force the companies having overhead wires in Philadelphia to put them underground. The city government of Philadelphia attempted this, and passed some very peremptory ordinances on the subject, but somehow failed to make any impression on the hard-hearted and obdurate companies. Now the Legislature has taken a hand, and the intellectual gentlemen from Bucks and Berks, where they still vote for Jackson and tell you it is a "whig lie" if you assert that "Old Hickory" is dead, will have a chance to learn all about "induction" and "retardation," and give the Quaker City the benefit of their mature and deliberate judgment.

Among the errors into which, in the early days of the telephone, before experience had taught its lessons, too many over sanguine companies fell, was that of supposing that the "plant," once established, would be enduring. It has been found that, taking into consideration the changes which improvements in apparatus of all sorts make imperative, as well as the repair and reconstruction necessary to make up for wear and tear, it is safe to estimate that entire renewal isnecessary at least once in five years, that is, out of receipts, at least twenty per cent. of the actual cost of the plant must be charged off annually, if the books are expected to tell the exact truth. This may seem to some a heavy allowance, but we are convinced that, viewed from a conservative stand point, nothing less can be counted upon. One opinion in this matter is based upon the experience of telephone men who have been in the business from the start, men whose experience has cost them dear, and is correspondingly valuable. In cities and large towns the wear and tear of iron wires is very great, and it is exactly here that the greatest amount is invested in them. Where copper wire is substituted for iron, although the first cost is greater, the depreciation is far less, and the efficiency shows no diminution so long as the wire is up.

We have recently seen some experiments and tests which give strong ground for the belief that not only can the coppering of carbons be dispensed with without injury to the light produced, but that uncoppered carbons can, when properly made, be used to very great advantage. Of course, the object of coppering is to increase conductivity. But it brings serious results in its train. The copper burns in the intense heat produced, and renders the light unsteady in color and in volume. Again, melted globules of copper fall into the shade and fasten themselves to it by melting the surface of the glass, producing spots and blotches which it is next to impossible to remove. But the greatest argument in favor of uncoppered carbons is economy in manufacture. The coating process is costly, as well in time consumed, as in material and labor, and if it can be dispensed with it will materially decrease the cost of production, and, as a result, the cost of the consumer. Of course the effort is to improve the conductivity of the carbons so that they will offer no more resistance when bare than when coppered, or not materially more. The experiments to which we refer have not been of sufficiently long duration as yet to prove that a commercial success has been attained, but the indications all point in that direction.

Of course some reason had to be assigned by the bears for last week's "scare" in Bell Telephone stocks, which carried the price down to 210, a figure which was attained before the result in the Drawbaugh case was made public. The "bugbear" this time was the suit of the Western Union Telegraph Company, and was talked about as a new "lion in the path." As a matter of fact it was entered about eighteen months ago, and has been making very slow progress ever since, the Western Union Company showing no anxiety to press it. Indeed it is over a year since the answer of the Bell Telephone Company was filed. The question at issue is one of contract. Under the agreement the Bell Telephone Company is to pay and does pay to the Western Union twenty per cent. of all royalty receipts. It is held that this does not require the Telephone Company to pay to the Telegraph Companyany part of the receipts which it derives from business which it does itself. For instance, the Bell Company for a long time owned and operated the Boston Exchange, doing the business without the intervention of a royalty-paying sub-company. Another source of income to the Telephone Company, destined in the future to be the chief one, is its interest in the capital stock of sub-companies, of which it holds shares to the nominal value of not far from $20,000,000. We understand that it is an interest in this, or at least in the income derived from it, that the Telegraph Company claims, and this claim the Telephone Company denies and resists. To bring up this suit, in which nothing new has occurred, and which will, according to present indications, hang along for years, was evidently a device of the bears to depress the stock and buy it in, but why holders who had every opportunity to inform themselves should have swallowed it without question and sacrificed their holdings, it is hard to understand.

At the hearing which took place in Springfield last week, on the petition of the Schuyler Electric Light Company, for permission to erect poles and run wires in the public streets, the business manager made one statement which deserves attention. It was to the effect that "petitions have recently been received from two cities for the system." This indicates a most extraordinary and gratifying state of things for electric lighting companies generally, and for this special company in particular. Think of it! Three short months ago, no sooner did a city or town show a willingness to consider the advisability to introduce electric lights, than a whole army of representatives of different companies swoop down upon them, each and every one of them "petitioning" for a hearing, and all ready to make any reasonable concession for the sake of getting a footing. But how different now! The Company sits serenely in its office, and "two cities," with, presumably, a long procession of others behind, stand at the office door, cap in hand, and "petition" for the privilege of having the electric light introduced within their limits. It is indeed a glorious and a gratifying change from the old method, and, if true, the good news will carry joy to many an electric light man's heart. No more worry, no more uncertainty, no more reaching out to seek and secure business. Naught to do, but to open one's mail regularly, and take out "petition" after "petition," and then, in a lordly way to decide which to grant and which to refuse. We trust that the prayers of the two petitioning cities have at least had attention and response, and that the inhabitants thereof have been spared the anguish of long-continued uncertainty and anxiety. And we trust that when the Schuyler Company's representative starts for Chicago to attend the convention, he will put those "petitions" in his pocket, that all who are there may feast their hungry eyes upon them.

A bill has been introduced into the Massachusetts Legislature looking to the regulation of telephone charges. What right the Legislature has to deal with telephone charges any more than with hotel charges it is difficult to see. True, it does deal with railroad fares, but the provision that it may do so is part and parcel of the railroad company's charter. Again, when it gives to a company the right to build and run a railroad between two cities or towns in the State, it practically, with rare exceptions, gives the company a monopoly of the business between those points, for no other company would think of coming in as a rival. Now people *must* travel, and if legislative interference in prices is *ever* justifiable—which we question, believing that the less "regulation" is applied to business the better for all concerned—it is here. But with telephone companies it is quite another matter. No one is obliged to have the telephone; it is, so far, rather an article of convenience and luxury than of necessity, and certainly it gets nothing from the State that gives it in any way the privileges or prerogatives of a monopoly. There is among all legislators just now an itching to interfere with business by setting bounds and limits, but the history of all such legislation in all countries shows that it has never been even partially successful. Indeed one need but learn the rudiments of political economy to know that if the telephone companies charge too much for their service they will suffer, because they will not get business. They may safely be trusted to charge all that the business will bear—as does the grocer—but anything beyond this they will quickly feel in loss of patronage. We do not apprehend that the Legislature of Massachusetts will even give the proposed bill serious thought, but it is one of the signs of the times that such a law is seriously asked for.

THE FUTURE OF THE ELECTRIC LIGHT.

Things move on so rapidly in this wonderful age of development, that one is continually startled by some new evidence of marked and most decided progress. Four or five years ago, the electric light was a thing so uncommon in the streets of even our largest cities, that passers by stopped to look at, to wonder, and to admire, while in the smaller cities they were utterly and entirely unknown. How is it to-day? Cities which do not have them are looked upon as behind the age, and the public has become so accustomed to the light that it expects and demands it, and, so far as possible, avoids streets and stores in which it is not used. This wonderful change has been brought about by the superior advantages which the lamp possesses over gas or any other illuminant, and by the persistent and unremitting endeavor of those who have been concerned in its introduction. The obstacles against which they have been forced to contend have been many and serious. Without referring specially to the opposition of the gas companies, or of that "old fogy" element which, in every community, is bound to set its force against improvement of every shape and sort, it is to be remembered that the business was new, that many mistakes were necessarily made, that for a long time, the whole thing, even after hundreds of thousands of dollars had been expended in establishing "plants," was in an experimental stage, and that experiments and mistakes, while instructive and therefore valuable, cost all that they can be called worth. But in the face of all this and of much more, of discouragement and of disparagement, the electric light has won its foothold, it has proved that it has come to stay, and the manufacturing companies are to-day, in the aggregate, turning out more lamps and dynamos than at any time since the first arc light was seen in

America. Meantime many over-sanguine expectations have failed of realization, a good many top-loftical ideas have had the wind let out of them, and things have come down to a more serious and sober realization that electric lighting is a business which, in all of its departments, is to be conducted on strict business principles. This, we take it, is the key-note of its future.

Beginning back at the factory where the apparatus is produced, it must, to find a market, be manufactured in the best manner and of the best materials, but at minimum cost. This can only be done by close purchasing of raw materials, the use of the best labor-saving machinery, and the closest supervision of every detail. Next, if the use of the electric light is to go on increasing, the apparatus made must be offered and sold at a fair advance on the cost of production. Were there but one system of arc lighting, the owners of the patents covering could afford to be very independent, and make their own terms. But this is not the case. There are other Richmonds in the field, and while each claims to be the best, and each holds that his light is worth more than that of his competitor, the fact is that price has a great deal to do with determining men's minds. Again, if lighting companies can buy their apparatus at reasonable rates, they can afford to furnish lights at a lower figure, and this, of course, means more lights. We ask for them only *reasonable* rates, and we venture the assertion that, in the past, too many of them have paid rates that were out of all reason. The expense of factory experiments and blunders can not always be charged in as a part of the cost of the product.

The time has come when the manufacture of dynamos and lamps has got to be put on a par with the manufacture of steam engines, and when they have got to be sold, if their sale is to continue steadily, at a fairly remunerative advance above first cost. That is what it has got to come to, that is what it will come to, and the longer the manufacturing companies hold out against it, the worse it will be for them when it does come.

Next is to be taken into account what the lighting companies must do. They must study every possible economy, they must employ men of experience to handle their apparatus and their business, they must see to it that they get the largest possible return for the money expended for fuel, carbons, and other supplies, and they must seek so to serve the public that their light will day by day advance in public favor and esteem.

We believe that just what we have outlined is being done, at least to a very large extent, and hence we firmly believe in the very great increase in electric lighting within the next five years. Incandescent lighting, as the natural and necessary companion of the larger and more ambitious "arc," is making rapid strides, especially since some of the larger items of expense which attend its introduction have been greatly reduced. Its very general use in the business portions of all our large cities is simply a question of time. As an illuminant for streets, public squares, and large enclosed spaces of all sorts when a great volume of light is demanded, the arc light is without a competitor. Its general use in all large cities as the sole illuminant for streets, to the total exclusion of gas, is simply a question of time, if the companies producing it and those manufacturing the apparatus for it will but put their business on a square, reasonable business basis.

The incorporation under the laws of New York of the American Electrical Railway Company is an event of general interest. That Cyrus W. Field and others of his family appear in the list of incorporators indicates that plenty of capital, technical knowledge, and business enterprise are behind the project.

The telephone girl was tired and slept late, and woke up with a start. She said she thought she heard somebody say "Hello." It was only her father shaving himself in the next room.

The Protection of Submarine Cables.

Extract from the "Bulletin Mensuel des Postes and des Telegraphes" (Monthly Bulletin of Posts and Telegraphs), No. 24, dated December, 1884. (Paris.)

Law respecting the Repression of Infractions of the International Convention of March the 14th, 1884, relative to the Protection of submarine cables.

The Senate and the Chamber of Deputies have adopted, the President of the Republic promulgates the Law, the tenor of which is as follows:

HEADING I.—*Special Regulations for Non-Territorial Waters.*

ARTICLE 1. Infractions of the International Convention of March the 14th, 1884—the object of which is to secure the protection of submarine cables—which may be committed by any individual forming part of the crew of a French vessel, shall be judged by the Correctional Tribunal, either of the district (*arrondissement*) in which may be situated the port to which the delinquent's ship belongs or of the district (*arrondissement*) of the first port of France into which the vessel may be taken.

ARTICLE 2. The prosecution shall be undertaken at the suit of the Public Ministry, without prejudice to the right of the civil parties.

ARTICLE 3. The minutes (*proces-verbaux*) drawn up agreeably to Article 18 of the Convention of the 14th March, 1884, shall not be subject to affidavit; they shall be held as proved until the requisite steps are taken to prove them false.

In default of minutes (*proces-verbaux*), or in the event of these deeds proving inadequate, the infractions may be proved by witnesses.

ARTICLE 4. Any one who may refuse to produce the documents requisite for drawing up the minutes (*proces-verbaux*) cited in the preceding articles, shall be liable to a fine of from 5 to 100 francs, and to imprisonment for a term of two to ten days.

ARTICLE 5. Every assault, every resistance accompanied with violence and the use of force, against the persons qualified by the terms of Article 10 of the Convention of March the 14th, 1884, to draw up the minutes (*proces verbal*) in the exercise of their functions, shall be punishable with the penalties applicable to rebellion according to the distinctions established in the penal code.

ARTICLE 6. Shall be punishable with a fine of 16 to 300 francs:

1. The captain of a vessel who, engaged in repairing or laying a submarine cable, shall fail to observe the rules respecting signals adopted with a view of preventing fouling.

2. The captain or master of any vessel who, perceiving or being in a position to perceive these signals, shall fail to turn away (back) or to keep (himself) at least at the distance of a nautical mile from the ship engaged in laying or repairing a submarine cable.

3. The captain or master of any vessel who, seeing or being in a position to see the buoys laid down to mark the position of the cables, shall fail to keep (himself) at the distance of at least a quarter of a nautical mile from the line of the buoys.

ARTICLE 7. Shall be punishable (punished) with a fine of 16 to 500 francs, and liable to imprisonment for a term of one to five days:

1. The captain or master of any vessel who shall have cast anchor within a quarter of a nautical mile of a submarine cable, the position of which he is in a position to know by means of lines of buoys or otherwise, or shall have moored to a buoy laid to mark the site of the cable, except in cases of circumstances beyond his control (*force majeure*).

2. The master of any fishing vessel who shall fail to keep his apparatus or nets at least one nautical mile from the vessel engaged in laying or repairing a submarine cable; fishing vessels, however, which perceive or are in a position to perceive the telegraph vessel showing the signals adopted, shall, in order to comply with the signal warning, be allowed sufficient time to finish the operation in hand, such time, however, not to exceed 24 hours.

3. The master of any fishing vessel who shall fail to keep his apparatus or nets at least one-quarter of a nautical mile from the line of buoys laid down to mark the position of the submarine cables.

ARTICLE 8. Shall be punished with a fine of 16 to 300 francs and liable to a term of imprisonment varying from six days to two months:

1. Whoever, through culpable negligence, and especially in the cases met by Articles 6 and 7, shall break a submarine cable, or shall cause an injury to it which may result in an interruption, or a hindrance, either entire or partial, to the means of telegraphic communication.

2. The captain of any vessel who engages in the laying or repair of a submarine cable, shall be the cause, through inobservance of the rules as to the signals adopted with the view of preventing fouling, of the breaking or injury to a cable committed by any other ship.

ARTICLE 9. Shall be punished with a fine of 16 to 300 francs, and liable to a term of imprisonment varying from six days to two months:

1. Whoever shall make, keep out of his house, put up for sale (sell), ship, or cause to be shipped, instruments or apparatus exclusively used for the purpose of cutting or destroying submarine cables.

2. Whoever shall make use of these instruments or apparatus.

ARTICLE 10. Shall be punished with a fine 300t o 1.000 francs and imprisonment varying from three to five years, whoever shall voluntarily (intentionally) break a submarine cable, or shall cause an injury to it which may interrupt or impede, either wholly or partially, the means of telegraphic communication.

The same penalties shall be pronounced against the authors of attempts of the same things.

The guilty party may in addition be placed under the surveillance of the high police for a maximum term of ten years, dating from the day he shall have suffered his penalty.

These regulations, however, do not apply to persons who may be compelled to break a submarine cable or to injure it through the actual necessity of protecting their lives or securing the safety of their ship.

The present Act (Law), resolved and adopted by the Senate and by Chamber of Deputies, shall be executed as a law of the State.

Done at Paris, December the 20th, 1884.

JULES GREVY,

By the President of the Republic.

JULES FERRY, President of the Council, Minister of Foreign Affairs.

MARTIN FEUILLE, Keeper of the Seals, Minister of Justice and Worship.

A. PEYRON, Minister of Marine and of the Colonies.

AD. COCHERY, Minister of Posts and Telegraphs.

Secondary Batteries.

Editor Electrical Review.

SIR:—Permit me to make a few remarks with reference to an article on Secondary Batteries in your issue of the 31st ult. "Electrolyte" has evidently been confusing matters by making no proper distinction between a special treatment of the lead plates prior to their "forming" and the "forming" itself. In his book "Recherches sur l'Electricite," Paris, 1879, which contains the substance of his sundry papers presented to the Academy of Science since 1859, Plante makes no mention of any previous preparation of the plates unless the incidental statement that "a prolonged immersion of the lead plates in acidulated water before they are acted upon by the primary current greatly facilitates the 'formation' of secondary couples" be construed in that sense. The second and principal claim in Faure's English patent (Jan. 11, 1881, No. 129,) reads as follows: "The process of obtaining plates or supports capable of retaining and preserving electro-chemical force or energy by covering them with a layer of porus or spongy metallic matter deposited to any desired thickness by galvanizing, chemically precipitating, or mechanical adhesion." The next secondary battery patent (No. 2,272) was granted to J. W. Swan, who says in his specification: "I prepare plates of lead having a cellular, corrugated, or grooved surface or surfaces of such a character as to be capable of retaining in the cells, grooves, corrugations, or interstices spongy or finely divided lead." J. S. Sellon's patent (No. 3,926) is the fourth of its kind after Swan's; he claims: "The use in the construction of secondary batteries of perforated plates or sheets roughened, serrated, or indented, composed of lead, platinum, or carbon, upon, in, or against which plates spongy or finely divided lead or oxides, or other salts or compounds of lead or other suitable substances or compounds, are, or may be, held or retained." These facts may be of some aid to a searcher after truth regarding the controversial subject of the article above referred to. I counted 133 patents and provisional protections on secondary batteries recorded at the English Patent Office in 1881 and 1882, while there were only two patents of that kind granted before 1881—one to Lontin in 1875, and one to Houston and Thompson in 1879. Most of the patents I found to be for all sorts of further improvements and modifications of what is generally accepted as Faure's invention. But from a French patent preceding his, it appears that he has been credited with too much and that, as regards the preliminary coating of secondary electrodes with finely divided lead, the priority belongs to d'Arsonval.

Yours respectfully,

A. PARTZ.

Philadelphia, Feb. 9, 1885.

Looking again into your journal I see it announced that Dr. Pabst of Stettin has devised a new primary cell with electrodes of carbon and wrought iron dipping into a solution of chloride of iron. If I am correct in supposing that the german "chlorid" was erroneously translated "chloride" (which would give but a very unsatisfactory current) instead of "perchloride," and that there is a mistake about both electrodes dipping into the same liquid (which would be speedily decomposed), then I described, if not the same, at least a very similar voltaic element in 1881 in "La Lumiere Electrique, T. III., No. 9. It consists of an iron anode in a solution of chloride of sodium and a carbon cathode in a solution of perchloride of iron, of about 30 degrees B., the liquids being separated by a porus clay cell. The electro-motive force of such an element is 1.2 volts and, as both liquids are good conductors, its internal resistance may be reduced to a fraction of an ohm. A battery on this plan has done me for several years excellent laboratory service. A. P.

Electric Bull's-Eye.

The London police authorities made some experiments last month with an electric bull's-eye, using for this purpose a lamp invented by M. Trouvé, the eminent French electrician, and capable by an ordinary voltaic current, and therefore without the intervention of a dynamo, of giving a remarkably steady and useful glow, applicable to many of the purposes for which improved lights are specially wanted. The experiment was made in a boat, which started from the Speaker's stairs on the Thames at 6 o'clock one evening. Two gentlemen held the reflectors, which are simply short hollow cones of brightly polished metal, each with an incandescent lamp in its center, and as the boat glided by the Members' terrace of the Houses of Parliament, the beam was thrown on the building and upon vessels on the water. The result was that the facade of legislative chamber and moving objects not absolutely black were shown brightly at 30 yards distance, less distinctly, but discernibly, at 50 yards. It is no libel on the oil lamp to say that it only rendered darkness more palpably obscure at 10 yards off. Then the boat was rowed under the arches of Westminster Bridge, and here, in a relatively confined space, the efficiency of the new illuminant was clearly demonstrated. None of the rays were lost by useless diffusion, and it needed only to flash the bull's-eye round to see every part of the framework of the bridge almost as well as in daylight.

Telephonic News

*** The *Mexican Financier* says the telephone has become in Mexico, as in all other advanced nations, an integral part of business life.

*** Telephonic communication between Rouen and Havre was opened recently, the charge being a franc for every five minutes. The two telephones are at the post and telegraph head offices; but the branch offices will eventually be accommodated, as also the telephone network in both towns.

*** From figures collected by Commissioner Butterworth, of the Patent Office, it appears that the number of telephone exchanges in the United States on January 1, 1884, was 906; number of miles of wire, 85,896; number of employees (exclusively of day laborers), 47,062; number of subscribers, 123,625. From these figures and others of like character the Commissioner argues that the multiplication of inventions has increased instead of reduced the demand for labor.

*** The Compania Telefonica, La Uruguaya, now under the control of Messrs J. K. Theobald & Co., of Buenos Ayres and Montevideo, which has in use over 700 Bell telephones in Montevideo, has given an order for 300 more to the United Telephone Company, River Plate. The United Company supplied at once 100 from a shipment arriving on 5th instant by the Malabar, and cabled for the remainder. La Uruguaya company expects to have 1,000 subscribers in Montevideo.

*** By the end of June last the Vienna telephone lines attained a length of 175 kilometers (108 miles). The total length of wire in the cables was 1,300 kilometers (807 miles), and in underground lines, of silicon bronze wire 1 mm. in diameter, 1,683 kilometers (1,045 miles). The number of subscribers was 708, and that of direct connections, 120. In the month of June nearly 52,000 messages were sent by the subscribers, making 1,750 a day. The two central offices, which open at seven o'clock in the summer and eight o'clock in winter, closing at nine o'clock, are served by 42 girls.

*** The shareholders of the River Plate Telephone Company and the Consolidated Telephone Company will doubtless be glad to hear that the manager of the former company, while on a short visit to England on business matters, reports that it is doing very well indeed, that all the leading people of Buenos Ayres are on the exchange, and that the Government uses the Gower-Bell instrument in preference to the Bell and Blake. The latest returns show 1,300 paying subscribers in Buenos Ayres, and a large increase in Monte Video since the company reduced its rates for subscribers to meet the opposition tactics; and no doubt this increase will be maintained as the Gower-Bell instrument is fully appreciated in the Argentine Republic, and it was solely the higher rates which drove the subscribers away.

*** An analysis of the accounts of the Inter-Continental Telephone Company, doing business in Caracas, La Guayra and Valencia, shows that for the five months from July 1, to December 1, the company earned gross $13,097.48, an average of $2,619.50 per month. The expenses were $5,926.04, an average of $1,059.21 per month, and the average net earnings $1,518.69 per month. This would be at the rate of, say, $18,000 per year from the 240 subscribers which the company then had. But the number of subscribers increased to 446 in December, with a prospect of reaching 500 early in January. The added 160 at $5 each per month would increase the gross-earnings by $800, with a nominal increase in expense. On this basis the management hopes to show net earnings of $25,000 for 1885. There is a project on foot to consolidate all the telephone companies in Brazil. The Tropical American Company has a large interest in all the Brazilian companies.

*** The statement of the Erie Telephone Company for the quarter ended Dec. 31, 1884, shows:

Gross earnings	$141,916.44
Expenses	86,931.18
Net earnings	54 985.26
Construction expenses	16,597.28
Surplus for quarter	38,387.98

The company completed all extra territorial work in hand during the quarter, expended $10,806.36 in repairs (which was charged to expenses), and $16,597.28 for new construction—in all $27,403,64.

*** The annual statement of the Bell Telephone Company, of Philadelphia, shows prosperity during the last year. The dividends were as follows:

January 15	3 per cent.,	$16,800
June 16	6 " "	33,600
December 16	.32 " "	179,200
Total for 1884	41 per cent.,	$229,600

The capital stock, all paid in, is $560,000; the cost of line and equipment, $403,630.06; gross expenses in 1884, $180,778.41; gross receipts, $389,677.17; taxes paid were $9,892.83. The number of circuits carrying one subscriber was 1,655; two subscribers, 149; over two subscribers, 23; total, 1,829; miles of wires on poles, 521; on buildings, 1,104; total, 1,625; number of conversations between subscribers per month, 240 each; number of operators, 56; total employes, 180. The number of subscribers was 2,187. The rates were $120 per annum for a radius of one mile from exchange for business purposes and $100 for residence purposes. The monthly rate was $10 for business and $8.33 for residence. This company has 521 miles of wire upon poles, the most of which belong to the city, and 1,104 miles of wires strung upon buildings.

*** Our correspondent speaking of the late tests of the Phelps instruments on trains, says: "On the New York, New Haven & Hartford Railroad, the first practical test of a railroad telegraph line by which constant communication can be kept up between a station and a moving train was made, the system being the invention of Lucius J. Phelps. The train upon which the test was made ran to New Rochelle, a distance of 15 miles. Telegraphic messages were sent and received from and by the moving train as perfectly as can be received and sent from station to station. The officers of the company, who were of the inspection party, expressed themselves entirely satisfied with the experiment.

"This may seem wonderful, but even this achievement appears likely to be outdone by a German invention just perfected, which electrically traces upon a diagram in the train despatcher's office the movements of all trains along the line. The apparatus consists of a sheet of opaque glass, on which the rails are indicated by horizontal lines and the stations by numbered vertical lines. Little arrows, representing the trains move along the horizontal lines. They are put in motion by aid of electricity, developed by the contact of metallic brushes attached to the locomotives with zinc bands placed along the rails. The train thus continually traces its trajectory on the glass indicator. The apparatus was exhibited a few days ago in Germany to a commission of Berlin scientists."

The Telephone in Business in Mexico.

The promptness with which the telephone system has been adopted in this country, not only here in the capital but in all the considerable cities of the Republic, is the best evidence of the adaptability of this new electrical appliance to Mexican business needs. The same causes which have made it a necessary part of a business outfit in the United States make it a necessary part of a business outfit here. Primarily, it assures that promptness and dispatch in receiving and filling orders which is the very life of trade. It avoids the uncertainty of a message, and the bother of a written order, by bringing—to all intents and purposes.—buyer and seller into the same room. It saves time, and it saves the loss of temper and the serious inconvenience consequent upon having an order misunderstood. It is a simplification of telegraphy that provides a means of communication more rapid and more direct than the telegraph affords, yet that can be used without technical skill.

Possessing these very desirable qualities, the telephone has secured its adoption here, as elsewhere, on the simple basis of convenience and economy of time. Being adopted, it has proved its further value as a stimulant to trade. The fact that an order can be given without the trouble of going or sending to the store where the article desired is to be found, so smoothes the way of buying that many purchases are made which certainly would not be made had the ordidary course to be pursued. This fact has been observed, and with much pleasure, in every business house into which the telephone has been introduced. Indeed, so marked has been the advantage gained by dealers, who in the various towns and cities have been the first to avail themselves of the benefits, that membership in the telephone exchange assures, that trade rivals, of more conservative tendencies, have been aroused to the necessity of adopting the new invention by a marked decrease in their business.

All of these causes, operating together, have made the introduction of the telephone into Mexico, as into the United States and Europe, a matter very easy of accomplishment. It has become here, as elsewhere, an institution of the country, and, being thus established, its use continues constantly to spread. Even the most conservative of tradesmen, with the most firmly footed objections to the introduction of new methods and appliances in the machinery of trade, cannot refuse to adopt this invention when they see clearly that not to use it is to surrender their business to their rivals. Thus the fact that the use of the telephone already is so general makes its practically universal adoption a business necessity. It has become in Mexico, as in all other advanced nations, an integral part of business life.—*Mexican Financier.*

Improvement in Telegraphing.

Mr. Selden, Superintendent of the Baltimore and Ohio Telegraph Co., whose headquarters are at the central company's building, at Baltimore, is the inventor and patentee of a sextuplex instrument, which has been adopted by the Baltimore and Ohio Company. The instruments have been set up, and, after thorough tests, the local Superintendent, Mr. Stewart, reports that they work admirably. Three messages can be sent simultaneously from each end of a single wire, and every word comes distinctly The sextuplex will be used between Baltimore and Washington as soon as the new quarters of the telegraph company in Washington are complete, and its use will be extended in other directions. Mr. Selden, it is stated, worked out his invention while he was a telegraph superintendent in the West.

An electrician says that it was a matter for notice among that class that Mr. Thomas A. Edison has very recently published a letter on telegraphy, in which he says that the limit of improvement has about been reached, and there remains probably nothing further to be done except to discover a sextuplex instrument that will transmit six messages simultaneously over a single wire. Mr. Edison enlarges at length upon the sextuplex principle.

Mr. Selden's invention is claimed to have passed beyond the field of experiment, and has been accepted as an established adjunct to their telegraph department by the Baltimore and Ohio Company.

Telephony in France and in England.

The Paris correspondent of the *Times* contributed to that journal recently an interesting account of the progress of telephonic communication in the French capital. He says:

"The working of the telephone in France, and especially in Paris, has been granted by a concession of the State to the Societe Generale des Telephones, and the extension of the term deserves notice now that social intercourse has been revolutionized by the use of this invention.

"It was generally thought that the Minister of Posts and Telegraphs would assume the working of it on the part of the State. Apprehensions on this score were entertained, and would certainly have arrested the diffusion of the telephone in France. There is in this country a latent dread of State inquisition, and everybody is persuaded that if the telephone were in the hands of the State verbal communications would cease to be a secret between the two speakers. No doubt this fear is groundless; but it is explained by the unceremoniousness with which the State takes cognizance of private telegrams; and foreign senders, especially from England, do not recollect that a non ciphered telegram to any well-known personage is known to the Government before it reaches its destination. It was therefore with some apprehension that the termination of the company's present term was awaited.

"As there is nothing harder to eradicate than prejudice, it is fortunate for the progress of the telephone and the satisfaction of the public that the concession of the Societe Generale has been renewed for five years. Although, with his ordinary sagacity, M. Cochery has reserved the right of the State to take over the enterprise, the way in which the present company shall acquit itself of its duty will probably determine how long the public will enjoy immunity for its verbal communications from the ever-dreaded intervention of the official ear. No doubt so long as the Ministry of Posts and Telegraphs is confided to the scrupulous direction of M. Cochery no such apprehension need be entertained; but in a country of incessant changes, where a Government inspiring confidence may be succeeded by one creating alarm, the public would not feel perfectly safe unless the often confidential and important dialogues passing through the telephone were safe from all official auditors.

"It is interesting from this standpoint to study the organization of the telephone service, which daily plays a more important part here, and the abolition of or interference with which would derange the habits of all Paris. The company possesses a central office, corresponding with 12 branches scattered over the city. With but few exceptions, the communication, which passes by the district office to the central, and thence to the person wanted, is obtained in from 30 to 40 seconds, and if this time be exceeded the delay is owing to the correspondent asked for not replying at once. The number of subscribers in Paris, according to the most recent statistics, is about 3,700, of whom 3,550 have communication and 150 are on the point of receiving it. The number of calls is on an average during the winter months 24,000 a day, and 1,000 a night from 7 in the evening to 8 in the morning, which gives an average of seven calls a day per subscriber.

"As the subscription is 600 francs per annum, or two francs for each working day, a call costs on an average 28½ cents. No telegram is so cheap or convenient as this, and the time taken for the delivery of a telegram averages an hour, whereas communication through the telephone is almost instantaneous. The rates, however, are considered high, and everybody expected a reduction in the new concession. This has not been made, the reason probably being that the Minister wished to avoid too keen a competition with the State telegraphs, and in view of the possibility of the State taking over the telephone, desired likewise to guard its liberty of action.

"The company's double wires are more than 5,000 kilometers in length. This double wire system, introduced a year ago, is one of the greatest improvements which the company has effected. Great inconvenience had been felt owing to the passage from one wire to another of communications and external noises. Many experiments were tried to remedy this 'induction,' and others will still be made; but at present the double wire system has been the most suc-

cessful, and, except when some clerk is negligent or incompetent, the sounds are transmitted in Paris with wonderful purity and ease.

"As to the rates, the company's view is that the rent paid to the city for the use of the sewers and the 10 per cent. of the gross receipts paid to the State amount to about 25 per cent. of its earnings, while a marked reduction would bring such an influx of new subscribers that the lines could not for a long t me be properly worked; besides which the telephone would be perverted into an amusement for idle people. The company now employs 200 persons, at salaries averaging 150 francs or 160 francs a month, lunch being provided for them.

"Fresh efforts have lately been made to accommodate the public without reducing the rates. Fifty telegraph offices will have telephone compartments, some of which are already fitted up; and for 50 centimes per five minutes a person may go and converse with a subscriber, or with anybody, at another office, with whom he has made an appointment. This system will steadily extend, and, although only begun three weeks ago, there has been an average of 60 communications a day. A person proposing to make a call will then, by going to the telegraph office ascertain whether his friend is at home, and, if not, will save a useless drive.

"Another improvement suggested by M. Cochery, and agreed to by the company, is the establishment of a telephone station at the cen'ral telegraph office, so that for 50 francs a year, not including, of course, the charge for the telegram, a subscriber can telephone a message for transmission by telegraph. This not only saves trouble but three quarters of an hour for a telegram sent abroad, and 25 minutes for one inside Paris. Another great step in advance, though not yet benefiting Paris, is the establishment, as mentioned last night of telephonic communication between Rouen and Havre.

"I will conclude with a classification of some of the Paris company's subscribers possessing a certain interest, and which will suggest inferences to the reader: Bankers, 234 in 1884. and, owing to the closing of 14 unsuccessful banks, 222 in 1885; brokers, 102; newspapers, 71; printers, 65; cab proprietors, 60; booksellers, 56; engineers, 50; builders, 41; stockbrokers, 37; publicists, 30; clubs, 27; architects, 27; restaurants, 26; railway companies, 26; hatters, 22; insurance companies, 21; barristers and solicitors, 21; hotels, 21; cafés, 21; theatres, 15; dressmakers, 14; Government offices, 9; physicians, 6; Chinese shops, 3; and embassies, 1, namely, that of Russia."

In its leading columns of Monday the *Times* referred to the communication given above, remarking that it "supplies materials for comparison with what has been effected in the same direction among ourselves. It appears from the account that the Parisians would have made little use of the telephone if it had remained in the hands of the Government, so that communications might have been audible to official persons who were not intended to hear them, but that the grant of a renewed concession to the Societe Generale is thought to have secured the privacy of messages, and that since this concession has been in force the instrument has come into far more general use in the French capital than in our own. The annual subscription in Paris amounts to 600 francs, or £24, against £20 in London; but the Paris subscribers are the more numerous. The total number is now 3,700, the last 150 being not yet supplied with instruments, so that only 3,550 are actually connected with the exchanges. In London, on the 15th of October, the total number of connected subscribers was 3,255, and the average monthly increase for the six preceding months had been 50, so that the total may by this time be 3,405. The average daily number of messages sent through each Paris instrument is seven, while the London company state that only a few instruments have a smaller daily average than five. When the enormously larger size and greater population of London are taken into account, it is manifest that the greater popularity of the telephone in the smaller city must be due, in some degree at least, to a more sagacious policy on the part of those by whom its distribution is controlled. One evidence of this is not far to seek. In London the use of the telephone is entirely restricted to annual subscribers, who have instruments fixed in their houses. The directors of the United Company divide mankind into two classes, subscribers and others—classes as distinct as Greeks and barbarians, as the chosen people and the Gentiles. The directors desire that the Jews should have no dealings with the Samaritans. They issue solemn warnings to their subscribers against the enormity of permitting any miserable non-subscriber to send a message over their lines. A man may be strictly upright and honorable in all his dealings, and the uneventful tenor of his life may be such that the Post Office and the telegraph suffice for his customary requirements; but to the directors of the telephone company he is the merest outcast. If an urgent need for rapid verbal communication with some distant person should by any chance come upon him, it is held that he is rightly punished by being refused the means of gratifying his desire, and that he ought to feel a glow of satisfaction in the thought that he is made useful to his species as a warning and an example. The directors do not even extend a cordial welcome to proselytes, but endeavor to impress upon them that their adhesion should have been notified at an earlier period. After an annual subscription has been paid, the hapless convert is compelled to wait some six weeks for his instrument, and he receives no privileges during his period of probation. The telephone companies have been plundered and bullied by the Post Office, and the directors, like the footman in the 'School for Scandal,' revenge themselves upon any victims from among the public whom chance may throw in their way.

"They manage these things better in France. Our correspondent tells us that in Paris fifty of the telegraph offices will have telephone compartments, some of which are already fitted up, and for fifty centimes for five minutes a person may go and converse with a subscriber, or with anybody, at another office, with whom he has made an appointment. In London a subscribing tradesman can receive orders by telephone only from those persons who are themselves subscribers. In Paris he can receive orders from any resident in the city, and it would clearly be worth while for the London subscribers to put strong pressure upon the company for the sake of obtaining the facilities which are given in France. That it would be in the interest of the company to give them does not admit of doubt; and the warning against permitting non-subscribers to send an occasional message is a pitiable instance of the way in which short-sighted and grasping people may overreach themselves. To the vast majority of Londoners the telephone is only a name. They are theoretically well acquainted with its working, but they have no real practical knowledge of the convenience attending upon its use. The sooner they acquire this knowledge the sooner they will become subscribers. In some emergency a resident in one part of London wishes to communicate quickly with a resident in another part. He would first think of a telegram, but he remembers that his friend is on the telephone exchange. He might run to the nearest neighbor who was in the same position, and, but for the official prohibition, he might be allowed to pass a question and answer over his wire. The answer might need a word of explanation, and this also would pass. The experience thus gained would do more to produce a desire to have a telephone than any amount of reading or of theoretical information. It is unquestionable that, if the non-subscribing public had free access to telephones at the telegraph offices, no retail tradesman could afford to be without a fixed instrument at his place of business."

The Baltimore & Ohio Telegraph Company will soon put up two more wires between Taunton and Boston; also one more to New Bedford, and one more to Fall River and Newport. They will also string one more between Providence and New York. Their wires are so full of business that an increase is imperatively demanded and cold weather will not hinder the work. In the spring, it is said, the line will be put through Maine to St. John, N. B., and from Albany to Montreal.

The Telephone in the Metropolis.

Our excellent contemporary, *Invention and Inventors' Mart* (London), says that the inventor may be said to have performed his task in connection with the telephone to such a point that its practical application can now be almost infinitely extended. Further improvements, as we have stated in a recent article, will doubtless follow, but for all practical purposes the invention is complete. Since the last important concessions were made by the Postmaster-General, several of our Telephone Companies have been actively engaged in availing themselves of the new facilities, and by the erection of trunk lines, and the establishment of public call offices, they have already placed further great advantages in the reach of their subscribers and the public. This has been chiefly the case with the National Telephone Company, and the Lancashire and Cheshire Telephone exchange, but for some reason or other the United Telephone Company, to whom the interests of the metropolis are committed, seems to lag behind. It is true that it has been erecting a trunk line between London and Brighton, but we hear as yet little of the establishment of public call offices, which would undoubtedly prove a great boon to the public and the subscribers, and give to the telephone in the metropolis that popularity which it lacks as yet. It is all the more surprising that the United Telephone Company is so slow in availing itself of the powers conferred upon it by the new licenses, as one of its directors, Mr. J. W. Batten, had for a considerable time agitated for the permission for the erection of public call offices in the different parts of London, and especially in the suburbs. The remaining directors of the United Telephone Company, however, are intelligent and energetic enough, and we should say that, even in the absence of Mr. Batten, they would, now that extension in this direction is no longer opposed by the Post Office, proceed to carry out the ideas for which he so valiantly broke many a lance in the press. The *Times* has lately published a long account of the progress of the telephone in Paris, which has suggested to our ponderous contemporary a leading article, in which the directors of the United Telephone Company and the Post Office alike, are somewhat severely criticised. It certainly is news to us that the United Telephone Company intends to keep up the division of mankind into two classes—subscribers and non-subscribers—and their policy would indeed be a mistaken one, if it did not comprise the establishment of public call offices. The latter measure would, of a certainty, obtain them a large accession of subscribers, for the advantage for a business man or members of his household and others with whom he has dealings, to be able to communicate with his office in the city from the suburbs or other parts of the metropolis by means of a neighboring telephone call office, is obvious.

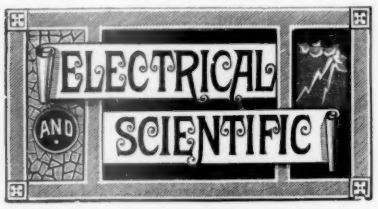
As to the progress of the telephone in France, it has only quite recently received a certain stimulus, chiefly in Paris, while extension in the provinces by no means equals that achieved in this country. The progress in France, in fact, offers no new features, and what is done in Paris can easily be done in London. The connection of the telephone exchange with the telegraph offices, has, under the new licenses, been granted, and nothing remains to be done than to extend the radius of telephonic communication, and to establish public communication with the subscribers to the telephone exchange from all parts of the metropolis and the suburbs. Had the *Times* instituted a comparison with the progress of the telephone in the United States, where the telephone has become an institution equalling in its usefulness almost the Post Office itself, its utterences would certainly have had much more point, for in the States the telephone exchanges number more subscribers than the rest of the world together. Let us hope that the United Telephone Company will take a leaf out of the book of the American Companies, which have thoroughly solved the question, how to make this invention available to the public.

TELEGRAPHIC

.... At a meeting of the board of directors of the Mexican Telegraph Company, held in New York last week, the usual semi-annual dividend of 4 per cent. was declared, payable Feb. 11. The net profit for the year ended Dec. 31 was over 10½ per cent. The company is without any bonded or other indebtedness, and has an available surplus amounting to $211,337. Notwithstanding the depression in business the traffic for 1884 shows a satisfactory increase over that of 1883. The present traffic of the Central & South American Telegraph Company shows an increase of 35 per cent. over the corresponding period last year. The cables of the Mexican company have not cost $1 for repairs since they were laid four years ago. The land lines of the company, 275 miles in extent, are composed of underground cables and substantial iron pole lines outside of cities.

.... The most recent link in the long chain of telegraph lines which is spreading with such rapidity over China, is the land line from Shanghai to Canton. A line from Pekin to Tientsin was opened a few months ago, and the capital of China was connected directly with London. Now the capital of southern China is joined with the metropolis in the North; and as Canton was put in communication by telegraph with the frontier of Tonquin at the outbreak of the present political troubles in the latter district, the telegraph now stretches in an unbroken line from Pekin in the north to the most southern boundary of the Chinese empire, and a message either from London or Pekin might reach the headquarters of the Chinese forces on the Tonquin frontier in a few hours. Four years ago the only telegraph line in China was one about six miles in length, stretching from Shanghai to the sea, and erected to inform the mercantile community of the arrival of vessels off the mouth of the river. The next important line constructed by the Chinese Government will probably be one uniting Pekin with the great northern lines across Siberia at Kiachta. This will have to cross the whole of Mongolia, and will give the capital of China a third alternative telegraph route to Europe, a matter to which some political importance is believed to be attached in China. As already pointed out in *Nature*, this extraordinary development is due solely to political considerations.

.... In the House at Columbus, O., last week, the joint resolution of Mr. Roche, requesting the Ohio delegation in Congress to favor, and urge the passage of Mr. Sumner's Postal Telegraph bill, was reconsidered and passed by a vote of 53 to 7. Mr. Bruce, of Hamilton, arose to a question of privilege in the House and stated that the votes of Messrs. Lowenstein and Peet, on the joint resolution of Mr. Roche, requesting Congressmen to vote for the Sumner Postal Telegraph bill, were recorded in the affirmative, and they denied that they had voted in favor of the measure. Messrs. Bohl and Brunner favored a committee of investigation and referred to a similar trouble at the last session. Mr. Roche claimed that this was another dodge of the Western Union monopoly to defeat his resolution, and charged that the lobbyists of that company had been working on the floor of the House to defeat the resolution. He charged that Mr. Bruce was in the pay of the Western Union, and held up a frank from that company which he said had been furnished to members of the House in order to control votes. Some of the Western Union officials were on the floor at the time Mr. Roche was speaking, but left immediately. It was stated that the Western Union officials had approached members on the Republican side and had used the argument that the measure was of a political nature, and that it should be defeated. This charge was at once denied and denounced by the Republicans, and one of the most spirited of contests followed. The Democrats then endeavored to hedge and kill the resolution to investigate, but were so sharply held in line that the motion to investigate was forced through, although the author of the resolution, voted to indefinitely postpone its consideration. In the Senate the resolution of Mr. Roche was read and referred to the Committee of Railroads and Telegraphs.



* * Bank of France, it is said, has an invisible studio in a gallery behind the cashiers, so that at a signal from one of them any suspected customer will instantly have his picture taken without his own knowledge. The camera has also become very useful in the detection of frauds, a word or figure that to the eye seemed completely erased being clearly reproduced in photographs of the document that had been tampered with.

* * In the new arrangement of accumulator devised by Signor Giovanni Garassino, cylindrical glass cells, like those used for an ordinary battery, contain discs, alternately of lead and ebonite, immersed in acidulated water and connected by metal wires. These accumulators are ready almost immediately after being charged to give out electrical energy; and the great thickness and area of the discs permit of retaining the charge for several days without much loss of energy.

* * The British Royal Geographical Society has received a communication from Capt. Willard Glazier, of the United States Navy, stating that he has discovered the true source of the Mississippi to be a lake of considerable size in latitude 47° 13′ 25″, having a level 3 feet above Lake Itasca, the hitherto supposed source of the river, and of a total altitude of 1,578 feet above the sea level. Taking former data as the basis, the length of the Mississippi is estimated at 3,184 miles.

* * The Dutch Society for the Promotion of Local Rail and Tram Ways offers a prize of 300 guilders for the best means of reducing and diminishing the pull and strain upon the horses in bringing the street cars into motion and to their normal speed, either by utilizing and turning to account the force wasted by frequent applications of the brakes, or by any other contrivance answering the same purpose. The apparatus must be so constructed as to allow of its being used in both directions when the car is in motion. Clear and distinct drawings or models must be sent in franco before the 1st of July to the "Secretary of the Society, Bahstraat 2 b, The Hague," and must be provided with a mark or symbol. The name and address of the sender must be enclosed in a sealed letter with the same indication (mark or symbol) on the envelope, for the purpose of identification.

* * Gaston Plante described, some years ago, under the name of "Walking electric spark," a peculiar phenomenon produced by the passage of an electric current of high tension. The appearances are so analogous to those of globular lightning, that he considers that phenomenon as a slow and partial discharge of the electricity from storm clouds, when that electricity is exceptionally abundant, and when the cloud itself, or the column of strongly electrified damp air, which forms its electrode, so to speak, almost reaches the ground, or is only separated from it by a thin layer of insulating air. Under these circumstances the ponderable matter which is traversed by the electric current collects under the form of a globe of fire. It is a kind of electric egg, without a glass envelope, which is formed by the rarefied and incandescent elements of air and vapor. The globe is not fulminating and dangerous by itself, for a breath is often sufficent to displace it or even cause it momentarily to disappear. Its presence, however, is formidable, for it brings the electricity from the storm cloud and reveals the chosen path of its escape. If the layer of air which separates the cloud from the ground is not traversed, the globe of fire may disappear without report. If a portion of the storm cloud approaches the earth or another conductor, the lightning may strike at a distance at the same moment that the globe disappears. If the layer of air is pierced, there is a flash of lightning accompanied by thunder, which is not due to the small quantity of electricity enclosed in the globe, but to the sudden discharge of a large portion of the electricity of the cloud.—*Comptes Rendes.*

On the Fritts Selenium Cells and Batteries.*

By C. E. Fritts, New York, N. Y.

In all previous cells, so far as I am aware, the two portions or parts of the selenium, at which the current enters and leaves it, have been in substantially the same electrical state or condition. Furthermore, the paths of the current and of the light have been transverse to each other, so that the two forces partially neutralize each other in their action upon the selenium. Lastly, the current flows through not only the surface layer which is acted upon by the light, but also the portion which is underneath and not affected thereby, and which therefore detracts from the actual effect of the light upon the selenium of the surface.

My form of cell is a radical departure from all previous methods of employing selenium, in all of these respects. In the first place, I form the selenium in very thin plates, and polarize them, so that the opposite faces have different electrical states or properties. This I do by melting it upon a plate of metal with which it will form a chemical combination, sufficient, at least, to cause the selenium to adhere and make a good electrical connection with it. The other surface of the selenium is not so united or combined, but is left in a free state, and a conductor is subsequently applied over it by simple contact or pressure.

During the process of melting and crystallizing, the selenium is compressed between the metal plate upon which it is melted and another plate of steel or other substance with which it will not combine. Thus, by the simultaneous application and action of heat, pressure, chemical affinity and crystallization, it is formed into a sheet of granular selenium, uniformly polarized throughout, and having its two surfaces in opposite phases as regards its molecular arrangement. The non-adherent plate being removed after the cell has become cool, I then cover that surface with a transparent conductor of electricity, which may be a thin film of gold leaf. Platinum, silver, or other suitable material may also be employed. The whole surface of the selenium is therefore covered with a good electrical conductor, yet is practically bare to the light, which passes through the conductor to the selenium underneath. My standard size of cell has about 2x2½ inches of surface, with a thickness of $\frac{1}{10000}$ to $\frac{5}{10000}$ inch of selenium. But the cells can, of course, be made of any size or form. A great advantage of this arrangement consists in the fact that it enables me to apply the current and the light to the selenium in the same plane or general direction, instead of transversely to each other, as heretofore done, so that I can cause the two influences to either coincide in direction and action, or to act upon opposite faces of the selenium and oppose each other, according to the effect desired.

Mode of measuring cells. So great is the sensitiveness of these cells to external influences, that it is necessary to adopt some particular system in measuring their resistance and to adhere strictly to that system, as every change in the method of measurement produces a difference in the result, and the different measurements would not be comparable with each other. The reason for this will be explained presently.

The system I have adopted is the Wheatstone's bridge arrangement, with equal sides, never using multipliers except for some experimental purpose. In each multiplier wire I have 500 ohms resistance. When the bridge is balanced, one-half of the current flows through the cell and acts upon the selenium. Between the bridge and the cell is a reversing switch, so that the current can be reversed through the cell without changing its course through the bridge. A Bradley tangent galvanometer is used, employing the coil of 160 ohms resistance. The Leclanche battery is exclusively used in measurements for comparison.

The kind of battery employed has a marked effect upon the sensitiveness to light which is largely reduced or entirely destroyed when the bichromate battery is used. The same cells again become extremely sensitive with the Leclanche battery. We might expect that a change in the current employed would cause a change in the resistance of a cell, but it is not clear how or why it should affect the sensitiveness of selenium to light.

"If one kind of battery current destroys its sensitiveness, may we not suppose that another kind might increase its sensitiveness? Although the Leclanche has operated well, some other may operate still better, and by its special fitness for use on selenium cells may intensify their actions, and so bring to light other properties yet unthought of. Is not here a promising field for experiment, in testing the various forms of battery already known, or even devising some new form especially adapted to the needs and peculiarities of selenium cells?"

One year ago I made the foregoing suggestions in a paper on "A New Form of Selenium Cell," presented before this association at Minneapolis. I am now at liberty to state that my photo-electric battery, presently to be described, marks an advance in the direction indicated. The current from this battery increases the sensitiveness of the cells to light, and also to reversal of current. One cell, whose highest ratio in light was about 83 to 1 with the Leclanche battery, when measured with my battery gave a ratio of 120 to 1. It seems to make the resistance of the cell both higher in dark and lower in sunlight than with the Leclanche battery. But the field is yet open to others for the discovery of a battery which may be still better for use with selenium cells.

The two surfaces of the selenium act differently towards currents sent into them from the contiguous conductors. One surface offers a higher resistance to the current than the other. The former I utilize as the anode surface, as I have found that the cell is more sensitive to light when the current enters at that surface, which is ordinarily the one covered by the gold or other transparent conductor. Some cells have this property but feebly developed; but in one instance the resistance offered to the current by the anode surface was 256 times as high as that offered by the cathode surface to the same current. In the majority of cases, however, the ratio does not exceed ten times.

Dual state of selenium. My cells, when first made, seem to have two states or conditions. In one, their resistance is very low, in the other it is high. When in the low state they usually are not very sensitive in any respect. I therefore raise the resistance by sending an intermittent or an alternating current through the cells, and in their new condition they at once become extremely sensitive to light, currents, and other influences. In some cases they drop to the low state again, and require to be again brought up, until, after a number of such treatments, they remain in the sensitive state. Occasionally a cell will persist in remaining in the insensitive state. The before-mentioned treatment raises it up for a moment, but, before the bridge can be balanced and the resistance measured, it again drops into the low or insensitive state. Some cells have been thus stimulated into the high or sensitive state repeatedly, and every means used to make them stay there, but without avail; and they have had to be laid aside as intractable.

In the earlier stages of my investigations, before the discovery of this dual state and the method of changing a cell from the insensitive to the sensitive condition, hundreds of cells were made, finished, and tested, only to be then ruthlessly destroyed and melted over, under the impression that they were worthless. Now I consider nothing worthless, but expect sooner or later to make every cell useful for one purpose or another.

The most singular part of this phenomenon is the wide difference in the resistance of the cells in the two states. In the low state it may be a few ohms, or even a few hundredths of an ohm. In the high state it is the normal working resistance of the cell, usually between 5,000 and 200,000 ohms, but is often up among the millions. The spectacle of a little selenium being stimulated, by a few interruptions of the current through it, into changing its resistance from a fraction of an ohm up to a million or several millions of ohms, and repeatedly and instantly changing back and forth, up and down, through such a wide range—we might almost say changing from zero to infinity, and the reverse, instantly—is one which suggests some very far-reaching inquiries to the electrician and the physicist. What is the nature of electrical conductivity or resistance, and how is it so greatly and so suddenly changed?

Radio-electric current generators. My cells can be so treated that they will generate a current by simple exposure to light or heat. The light, for instance, passes through the gold and acts upon its junction with the selenium, developing an electromotive force which results in a current proceeding from the metal back, through the external circuit, to the gold in front, thus forming a photo-electric dry pile or battery. It should preferably be protected from overheating by an alum-water cell or other well-known means.

The current thus produced is radiant energy converted into electrical energy directly and without chemical action, and flowing in the same direction as the original radiant energy, which thus continues its course, but through a new conducting medium suited to its present form. This current is continuous, constant, and of considerable electromotive force. A number of cells can be arranged in multiple arc or in series, like any other battery. The current appears instantly when the light is thrown upon the cell, and ceases instantly when the light is shut off. If the light is varied properly, by any suitable means, a telephonic or other corresponding current is produced, which can be utilized by any suitable apparatus, thus requiring no battery but the selenium cell itself. The strength of the current varies with the amount of light on the cell, and with the extent of the surface which is lighted.

General Observations on the Properties of Cells.

From the number of different properties possessed by my cells, it might be anticipated that the different combinations of those properties would result in cells having every variety of action. This is found to be the case. As a general rule, the cells are noteworthy in one respect only. Thus, if a cell is extremely sensitive to light, it may not be specially remarkable in other respects. As a matter of fact, however, the cells most sensitive to light are also "U B cells."

The property of sensitiveness to light is independent of the power to generate current by exposure to light, the best current-generating cells being only very moderately sensitive to light, and some of the most sensitive cells generate scarcely any current at all. Current-generating cells are, almost without exception, "U B cells;" and the best current-generating cells are strongly polarized, showing a considerable change of resistance by reversing the direction of a current through them; and they are also strong "anode cells," *i. e.*, the surface next to the gold offers a higher resistance to a battery current than the other surface of the selenium does. The power to generate a current is temporarily weakened by sending a battery current through the cell while exposed to light, in either direction. The current generated by exposure to light is also weakened by warming the cell, unless the cell is arranged for producing current by exposure to heat.

The properties of sensitiveness to light and to change of battery power are independent of each other, as I have cells which are sensitive to change of current, but absolutely insensitive to light—their resistance remaining exactly the same whether the cells are in darkness or in sunlight. I also have cells which are sensitive to light, but are unaffected by change of battery power, or by reversing the direction of the current through them.

The sensitiveness to change of battery power is also independent of the sensitiveness to reversal of direction of the current. Among the best "L B cells." some are

*Paper read before the American Association for the Advancement of Science, at Philadelphia.

"anode cells" and others are "cathode cells," while still others are absolutely insensitive to reversal of current or to the action of light.

Constancy of the resistance. A noticeable point in my cells is the remarkable constancy of the resistance in sunlight. Allowing for differences in the temperature, the currents, and the light, at different times, the resistance of a cell in sunlight will remain practically constant during months of use and experiment, although during that time the treatments received may have varied the resistance in dark hundreds of thousands of ohms—sometimes carrying it up, and at others carrying it down again, perhaps scores of times, until it is "matured" or reaches the condition in which its resistance becomes a constant.

As has already been stated, the sensitiveness of a cell to light is increased by proper usage. This increased sensitiveness is shown, not by a lowered resistance in light, but by an increased resistance in dark. This change in the cell goes on, more or less rapidly, according as it is retarded or favored by the treatment it receives, until a maximum is reached, after which the resistance remains practically constant in both light and dark, and the coil is then "matured" or finished. The resistance in dark may now be 50 or even 100 times as high as when the cell was first made, yet, whenever exposed to sunlight, it promptly shows the same resistance that it did in the beginning. The various treatments, and even accidents, through which it has passed in the meantime, seem not to have stirred its molecular arrangement under the action of light, but to have expended their forces in modifying the positions which the molecules must normally assume in darkness.

Practical applications. There are many peculiarities of action occasionally found, and the causes of such actions are not always discernible. In practice I have been accustomed to find the peculiarities and weaknesses of each cell by trial, developing its strongest properties and avoiding its weaknesses, until, when the cell is finished, it has a definite and known character, and is fitted for certain uses and a certain line of treatment, which should not be departed from, as it will be at the risk of temporarily disabling it. In consequence of the time and labor expended in making cells, in the small way, testing, repairing damages done during experiments, etc., the cost of the cells now is unavoidably rather high. But if made in a commercial way all this would be reduced to a system, and the cost would be small. I may say here that I do not make cells for sale.

The applications or uses for these cells are almost innumerable, embracing every branch of electrical science, especially telegraphy, telephony and electric lighting, but I refrain from naming them. I may be permitted, however, to lay before you two applications, because they are of such general scientific interest. The first is my

Photometer. The light to be measured is caused to shine upon a photo-electric current-generating coil, and the current thus produced flows through a galvanometric coil in circuit, whose index indicates upon its scale the intensity of the light. The scale may be calibrated by means of standard candles, and the deflections of the index will then give absolute readings showing the candle-power of the light being tested. Or the current produced by that light and that produced by the standard candle may be compared, according to any of the known ways of arranging and comparing different lights, the cell being lastly exposed alternately to the two lights, to see if the index gives exactly the same deflection with each light.

This arrangement leaves untouched the old difficulty in photometry, that arising from the different *colors* of different lights. I propose to obviate that difficulty in the following manner: As is well known, gold transmits the green rays, silver the blue rays, and so on; therefore, a cell faced with gold will be acted upon by the green rays, one faced with silver by the blue rays, etc. Now, if we construct three cells (or any other number), so faced that the three, collectively, will be acted upon by all the colors, and arrange them around the light to be tested, at equal distances therefrom, each cell will produce a current corresponding to the colored rays suited to it, and all together will produce a current corresponding to all the rays emitted by the light, no matter what the proportions of the different colors may be. The three currents may act upon the same index, but each should have its own coil, not only for the sake of being able to join or to isolate their influences upon the index, but also to avoid the resistances of the other cells. If a solid transparent conductor of electricity could be found which could be thick enough for practical use and yet would transmit all the rays perfectly—*i. e.*, transmit white light unchanged—that would be still better. I have not yet found a satisfactory conductor of that kind, but I think the plan stated will answer the same purpose. This portion of my system I have not practically tested, but it appears to me to give good promise of removing the color stumbling block which has so long defied all efforts to remove it, and I therefore offer it for your consideration.

Photo-electric regulator. My regulator consists of a current-generating cell arranged in front of a light, say, an electric lamp whose light represents the varying strength of the current which supports it. The current produced in the cell by this light flows through an electro-magnetic apparatus by means of which mechanical movement is produced, and this motion is utilized for changing resistances, actuating a valve, rotating brushes, moving switches, levers or other devices. This has been constructed on a small scale and operates well, and I think it is destined to be largely used, as a most sensitive, simple and perfect regulator for currents, lights, dynamos, motors, etc., etc., whether large or small.

Large and Small Dynamos?

In a work on the electrical transmission of power, M. Marcel Deprez and M. Japing state that a great many problems connected with this subject may be solved with the machines already constructed and the means actually at command, and also that the tendency is to large machines. Commenting on this, the *Bulletin International des Telephones* observes that electric lighting experiments in England and Austria with alternate-current machines do not appear to have settled the question; Edison with his continuous current machines does not seem to have exceeded 40 or 50 horse-power, a long way off 200 horse-power; and M. Marcel Deprez's experiments at Creil have special interest in this connection. Our contemporary, however, asks if, in every respect, large machines give comparatively better results than small. It is intended that the generating machines at Creil shall weigh from 35 to 40 tons for a current of 7,500 volts and 20 amperes, equal to 200 horse-power at starting. The receiving machines at Paris will weigh from 7 to 8 tons, and communicate to the shaft an available work of 30 to 35 horse-power, whence it follows that the weight per horse-power will be about 175 kilograms (3½ cwt.) for the generator, and 200 kilograms (nearly 4 cwt.) for the receivers, under the most favorable conditions.

Now, in the present machines, such as the Gramme, for instance, the weight per horse-power does not attain 40 or 80 kilograms (rather over 7½ or 15 cwt.), according as they are used as generators or receivers. Therefore, the mean weight of matter per horse-power in large electrical machines will greatly exceed that of small machines. Here is a contradiction not generally met with. But, adds the *Bulletin*, this is not the first time that electricity quits beaten paths; and such small details will be no bar to ultimate success.

The Bay line of steamers, running between Baltimore and Norfolk were the first to adopt the incandescent Electric Light System in this country.

A recent report forwarded from Vienna by Consul-General Weaver, states that recent experiments with Sedlaczek's electric locomotive head-light on the Western Railway have been pronounced by the public prints so successful, that he begs to transmit a few items in regard thereto, which may prove of interest to American specialists. He writes:

"The conception of illuminating the railroad track by means of an electric light attached to the head of the locomotive has long since ceased to be a novelty in railway engineering, while the advantages to be derived therefrom, if successfully accomplished, have furnished sufficient spur to urge inventors to the greatest possible researches and endeavors.

"Success, however, has been rendered very difficult from the fact that the oscillations and jars of the engine while in motion soon destroyed the delicate apparatus of the best electric lights known, and that a cheap and convenient method of generating the electric current—not immediately dependent on the continuous movement of the locomotive—proved difficult to obtain. In 1881, Mr. Sedlaczek, chief of the telegraphic service at Leoben, in Austria, aided by Mr. Schuckert, of Nuremberg, after six years of trial, succeeded in obtaining, it is affirmed, these two great desiderata, first by adopting as generator a Gramme machine with a Brotherhood motor furnished with an automatic regulator, having likewise attached thereto a Schuckert dynamo-electric machine. To obtain sufficient current required from 700 to 800 revolutions of the electric motor, demanding about three horse-power, being less than 2 per cent. of the force of the locomotive; and second, the light was procured by a Sedlaczek lamp, invented specially for the purpose, having a force of 500 carcel jets. The electric machine was placed on the boiler, just behind the smoke-stack, and brought under the immediate control of the engineer.

"The first experiments took place in September of 1881, between Leoben and Judenburg, on the 'Kronprinz-Rudolf Bahn,' a distance of 50 kilometers, with great success, it is affirmed; to the end that the road for a kilometer before the locomotive was rendered light as day. The white signals were marvelously brought out upon the black background, and the lights and lamps appeared like yellowish points. The same experiments tried last October between Munich and Diesenhofen, of the Munich-Salzburg line, resulted in even greater success, as may be seen from the official certificate of the President and Secretary of the commission of experts named by the Munich Electric Exhibition, a copy of whose translation accompanies this communication."

—— The patrons of the dining car on the "New England limited" of the New York & New England railroad were most agreeably surprised last Saturday evening by finding the car brilliantly lighted by a dozen incandescent lights, and the improvement, although an experiment, gives promise of being very successful, and can but add to the popularity of the "limited." The lights are supplied by batteries which are placed in a little room adjoining the stateroom. There are four batteries of six cells each, and the Woodhouse & Rawson lamps are used. The battery used is the Trouve, and consists of a wooden trough in which are fitted half a dozen ebonite cells, each containing one zinc and two carbon elements, connected by movable clamps. These elements or plates are attached to a little windlass, by which they are lowered into and raised from the exciting solution. It is not claimed that the light is as cheap as that furnished by oil lamps, but it is better and much safer, and is said to be as cheap as gas at $2 per 1,000 feet. Besides the lamps in the car, one is located over the platform, which is a great convenience in getting on and off the car in the evening.

—— A company has been organized at Ithaca, N. Y., for electric lighting, using the Brush system. Their motive-power will consist of two Ball engines, 60 horse-power each, and two steel boilers.

ELECTRIC LIGHT NEWS

—— A new electric light plant is being put in at Norwich, Conn; the capital stock, to be subscribed, is fixed at $25,000. Armington & Sims, of Providence will furnish the engines, and the boilers will be set with the Jarvis settings; the work is being rapidly pushed forward and in a few weeks will be in operation.

—— Circulars were sent out by a local committee in Chicago this week to all companies engaged in electric lighting supplementing the call already announced by the REVIEW for a convention at Chicago on the 25th inst.

—— A special meeting of the Society of Arts was held at the Institute of Technology in Boston last week, to listen to a paper on "The Edison Central Station Electric Lighting System," by Mr. W. J. Jenks, Superintendent of the Brockton plant. The paper, with the subsequent discussion by prominent electricians, developed a number of facts of great practical and commercial importance. A brief statement of the transmutations of energy from the heat of the sun through coal, steam, and magnetic induction to the light and heat of the electric lamp was followed by an explanation of the electrical terms resistance, intensity, electromotive force, quantity, etc., and of the units employed in their measurement. As the power obtained from a steam engine never exceeds 10 per cent. of the intrinsic energy of the coal consumed, and as about 80 per cent. of the power expended in the Edison dynamos is transformed into light and heat in the lamps, it follows that the latter utilize from 6 to 8 per cent. only of the actual energy of the coal, and that, could electricity be produced directly from coal, a problem which it is Mr. Edison's great ambition to solve, a vast saving would be effected, the commercial importance of which would probably far exceed the greatest of the mechanical discoveries of the age. The use of water power in running dynamos is highly economical, and turbines are always employed wherever practicable.

Regarding the relative efficiency of arc and incandescent lamps, it is found that a light of 2,200 candles nominal, or 1,200 candles actual, is obtained per horse-power in the arc system, as compared with 120 candles in the incandescent. The "three-wire system" was explained, and its advantages were stated to consist in a reduction of the weight of copper used, in an increase of the electromotive force and in the practical conveniences of connecting lamps to be used at varying hours.

The engines employed in running the dynamos are the Armington and Sims, which, from peculiar adaptation to the work required, have entirely displaced the Porter-Allen engine in central stations, and have stood the most severe and exacting tests. At the conclusion of the paper, Mr. Jenks introduced Mr. W. L Garrison, the treasurer and originator of the Brockton company, who gave a number of interesting facts regarding the commercial aspect of electric lighting. In response to inquiries, Mr. Garrison stated that the expense to the consumer had been fixed at 1 cent per hour for a 10-candle lamp, this being on the basis of gas at $2 per 1,000 feet, to which price the gas in Brockton immediately fell upon the introduction of the electric light.

In Lawrence the Sprague motor, giving from one to three horse-power, is being used in the same circuit as the lamps with satisfactory results, and the number of lamps connected is nearly 2,800.

Mr. C. J. H. Woodbury stated that the total number of Edison lamps in this country is 109,800, of which 34,800 are connected with a central station, and 75,000 are in individual plants. The earnings of the New York plant are at present more than three per cent.

ELECTRICAL PATENTS

INDEX OF INVENTIONS FOR WHICH LETTERS PATENT OF THE UNITED STATES WERE GRANTED IN THE WEEK ENDING FEBRUARY 3, 1885.

311,472 Annunciator for telephone systems; William A. Childs, Englewood, N. J., and Frank Shaw, New York, N. Y.
311,516 Galvanic battery porous cup; Charles P. Orne, Cambridge, Mass.
311,521 Telegraph Cable; William R. Patterson, Chicago, Ill., assignor to the Western Electric Company, same place.
311,522 Method of repairing telegraph cables; William R. Patterson, Chicago, Ill., assignor to the Western Electric Company, same place.
311,523 Means for hanging telegraph cables; William R. Patterson, Chicago, Ill., assignor to the Western Electric Company, same place.
311,546 Electric arc lamp: Barton B. Ward, Hartford, Conn., assignor to Frank B. Waterhouse, Sacramento, Cal.
311,547 Dynamo-electric machine; Frank G. Waterhouse, Sacramento, Cal.
311,611 Electrical connecting cord; William H. Sawyer, Providence, R. I.
311,616 Electric circuit connection; Thomas T. Smith, London, England.
311,617 Portable electric lamp; Thomas T. Smith, London, England.
311,630 Electric battery; Alden M. Young, Waterbury, Conn., assignor of one-fourth to David S. Plume, same place.
311,681 Electric circuit opener; William H. Sawyer, Providence, R. I.
311,682 Electric circuit; William A. Shaw, Brooklyn, assignor to Charles A. Cheever, New York, N. Y.
311,725 Demonstrative electrical apparatus; Jas. D Culp, San Felipe, Cal.
311,756 Combined audible stock quotation system and fire telegraph; F. Benedict Herzog, New York, N. Y.
311,757 Audible quotation indicating system; F. Benedict Herzog, New York, N. Y.
311,840 Knob for electric gas lighting apparatus; F. Lane, Boston, Mass., assignor to Thomas C. Frenyear, Exeter, N. H., and Lloyd E. Razee, Attleborough, Mass.
311,846 Indicator for railroad switches; Gelbert Otte, Apeldoorn, Holland.
311,852 Carbon battery element; Isaiah L. Roberts, Brooklyn, N. Y., assignor of one-half to Henry L. Brevoort, same place.
311,853 Electric battery; Isaiah L. Roberts, Brooklyn, N. Y., assignor of one-half to Henry L. Brevoort, same place.

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